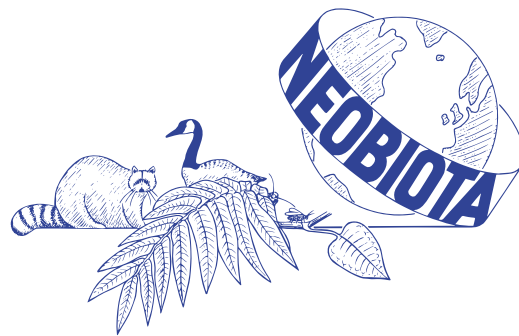


Book of Abstracts

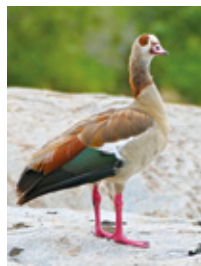
Christian Ries & Yves Krippel (eds)



NEOBIOTA 2016

Biological Invasions: Interactions with Environmental Change

9th International Conference on Biological Invasions



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Vianden, Luxembourg
14 - 16 September 2016

www.neobiota2016.org



Fonds National de la
Recherche Luxembourg

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NEOBIOTA 2016

Biological Invasions: Interactions with Environmental Change

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Book of Abstracts

Christian Ries & Yves Krippel (eds)

Fondation faune-flore
Institut de recherche sur le patrimoine naturel et la diversité biologique

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Table of contents

Partners & Sponsors	6
Introduction	7
Committees	8
Conference programme	9
Oral presentations.....	17
K1 Biological invasions and climate change	18
S1 Biological invasions and climate change	19
S2-3 Invader traits and characteristics of invaded communities	25
S3 Ecological impacts of biological invasions.....	35
K2 Biogeography and macroecology of invasions	40
S4-5 Biogeography and macroecology of invasions	41
S5 Invasive species and changes in landuse.....	48
K3 Non-native pests and pathogens.....	50
S6 Non-native pests and pathogens.....	51
S6 Socioeconomic impacts of biological invasions	53
S6 Restoration of invaded ecosystems	54
K4 Genetics and evolution of invasive species.....	56
S7-8 Genetics and evolution of invasive species.....	57
S8 Engaging the public with the topic on invasive species.....	63
K5 Eradication, management & control of invasive species	66
S9-10 Eradication, management & control of invasive species	67
S10 Biosecurity and risk assessment, including early detection and rapid response	73
Poster presentations.....	79
T01 Biological invasions and climate change.....	80
T02 Invader traits and characteristics of invaded communities.....	87
T03 Ecological impacts of biological invasions	116
T04 Biogeography and macroecology of invasions.....	139
T05 Invasive species and changes in landuse	156
T06 Non-native pests and pathogens	166
T07 Socioeconomic impacts of biological invasions.....	174
T08 Restoration of invaded ecosystems.....	176
T09 Genetics and evolution of invasive species	178
T10 Engaging the public with the topic on invasive species	197
T11 Eradication, management & control of invasive species.....	205
T12 Biosecurity and risk assessment, including early detection and rapid response.....	228
NEOBIOTA - European Group on Biological Invasions.....	244
NEOBIOTA conferences	245
NeoBiota Journal.....	246
Index of authors.....	248

NEOBIOTA 2016 Partners and Sponsors

NEOBIOTA 2016 is organized by

- Fondation faune-flore - Institut de recherche sur le patrimoine naturel et la diversité biologique, Luxembourg

in co-operation with our international Partners

- NEOBIOTA - European Group on Biological Invasions
- European Weed Research Society (EWRS)

in co-operation with our Luxembourgian Partners & Sponsors

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- Parc naturel de la Haute-Sûre
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- Conference Management System (COMS), Korneuburg, Austria
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- The Loupe IT-Services, Vianden

Cultural programme

- Ancien Cinéma a.s.b.l., Vianden

Catering

- Restaurant Veiner Stuff, Vianden
- De Schnékert, Windhof/Koerich

Introduction

“So globalised has everything become, that nothing is left in its accustomed place.”

“Nil, qua fuerat sede, reliquit pervius orbis.”¹

Senecio, Medea II, V: 317.

Biological invasions are one of the components of global change, causing dramatic impacts on biodiversity and ecosystems. As in former conference editions, NEOBIOTA 2016 provides an international high-level forum to discuss how invaders respond to environmental changes and their feed-backs. Furthermore, the conference concentrates on the most recent studies on ecological and evolutionary characteristics of invasive alien species (IAS), invaded ecosystems and their management.

NEOBIOTA seeks a broad perspective, presenting oral and poster presentations on any taxonomic group, from microorganisms to vertebrates, any ecosystem type, and any region of the world. The conference constitutes an important opportunity to strengthen collaboration between the scientific community, conservation agencies, as well as policy and decision makers.

NEOBIOTA brings together a number of outstanding experts dealing with various aspects of biological invasions, including climate change, changes in land use, ecological and socioeconomic impacts, non-native pests and pathogens, genetics and evolution, invader traits and characteristics of invaded communities, biogeography and macroecology of invasions, ecosystem restoration, biosecurity and risk assessment, eradication, management and control of IAS and, lastly, ways to engage the public with the topic of IAS.

As for the abstracts submitted to NEOBIOTA 2016, we printed them as they were submitted by the authors, who assume responsibility for their own contents.

Two COST actions have meetings adjoining NEOBIOTA 2016 on September 11th-13th: *Sustainable management of Ambrosia artemisiifolia in Europe* (SMARTER, FA1203, 2013-2017) and *European Information System for Alien Species* (Alien Challenge, TD1209, 2013-2017).

In the name of the Organizing Committee we hereby express our thanks to the Scientific Committee for the peer reviewing of the submissions, and to all partners and sponsors for their support. Their names can be found on dedicated pages inside this abstract book.

Luxembourg, August 2016
Christian Ries & Yves Krippel

www.neobiota2016.org
www.neobiota.eu

¹ Classical translation: “The world, now passable throughout, has left nothing where it once had place.”

NEOBIOTA 2016 Conference Committees

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1. Christian Bohren, Agroscope, Nyon (CH)
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6. Simone Schneider, SICONA, Olm (LU)
7. Uwe Starfinger, Julius-Kühn-Institut, Braunschweig (DE)

NEOBIOTA 2016 - CONFERENCE PROGRAMME

Venue: Cultural centre Larei, Vianden, Luxembourg

All oral communications @ Main conference room

Poster spaces @ Sports Hall & Besseling Room & Gallery

Coffee breaks and Lunches @ Sports Hall

Wednesday, 14 September 2016

08:00 - 09:00 Registration @ Foyer

09:00 - 09:45 Conference opening
Christian Ries (Organizing Committee), Montserrat Vilà (Neobiota Consortium), Guy Arendt (Secretary of State for Culture), Carole Dieschbourg (Minister for the Environment), Marie-Claude Marx (National Research Fund Luxembourg).

Keynote 1 Biological invasions and climate change. Chair: Franz Essl

09:45 - 10:30 We-K-01 Cascade Sorte
Will climate change increase the success and impacts of invasive species?

10:30 - 11:15 Coffee break

Session 1 Biological invasions and climate change. Chair: Franz Essl

11:15 - 11:30 We-S1-01 - Caroline Müller
Impacts of drought and plant origin on growth and tolerance of the invasive perennial *Tanacetum vulgare*

11:30 - 11:45 We-S1-02 - Anibal Pauchard, Jonas Lembrechts, Jonathan Lenoir, Martín Nuñez, Charly Geron, Arne Ven, Ivan Nijs, Ann Milbau
Using elevational gradients to understand plant invasions in cold environments: a field experiment in Sweden and Chile

11:45 - 12:00 We-S1-03 - Jesse Kalwij, Alexandra Erfmeier
Population dynamics of alien plants in a montane ecosystem

12:00 - 12:15 We-S1-04 - Huseyin Onen, Shahid Farooq, Hikmet Gunal, Cumali Ozaslan
Successful Adaptations to Adverse Environmental Conditions: More Areas under the Risk of Ragweed Invasion?

12:15 - 12:30 We-S1-05 - Miriam Zemanova, Olivier Broennimann, Antoine Guisan, Eva Knop, Gerald Heckel
Slug invasion and climate change: phylogenetics, interception records and climatic niche help elucidate global spread of *Arion* species

12:30 - 12:45 We-S1-06 - Matt Hill, Cleo Bertelsmeier, Susana Clusella-Trullas, Jeff Garnas, Mark Robertson, John Terblanche
Insect invasions under climate change: an agroecological perspective

12:45 - 14:00 Lunch & Poster session

13:10 - 13:50 EWRS information meeting @ Besseling Room (1st floor)

Session 2 *Invader traits and characteristics of invaded communities.* Chair: Emili García-Berthou

- 14:00 - 14:15 We-S2-01 - Bruce Osborne, Margherita Gioria, Mauricio Mantoani
Early Growth and Development as a Key Defining Feature of Plant Invasions
- 14:15 - 14:30 We-S2-02 - Margherita Gioria, Petr Pyšek
Germination strategies and plant invasions: current knowledge, gaps and challenges
- 14:30 - 14:45 We-S2-03 - Andreas Menzel, Stefan Hempel, Stefan Klotz, Mari Moora, Petr Pyšek, Matthias Rillig, Martin Zobel, Ingolf Kühn
Mycorrhizal status interacting with morphological traits help explaining invasion success of alien plant species
- 14:45 - 15:00 We-S2-04 - Petr Pyšek, Jan Suda, Jan Cuda, Wen-Young Guo, Magdalena Lucanová, Hana Skálová, Laura Meyerson
One ring rules them all: genome size as a driver of invasiveness in plants
- 15:00 - 15:15 We-S2-05 - Samuel Levin, Claudia Stein, Tiffany Knight
Phylogenetic novelty alters the strength of biotic interactions for native and exotic plant species
- 15:15 - 15:30 We-S2-06 - Philip Hulme, Maud Bernard-Verdier
Linking divergence and dissimilarity in native and alien species traits to address invasions of plant communities
- 15:30 - 15:45 We-S2-07 - Jane Molofsky, Jan Divisek, Milan Chytrý, Petr Pyšek, Brian Beckage, David Richardson, Nicholas Gotelli
Functional trait differences between native and invasive species across six habitats in the Czech Republic
- 15:45 - 16:00 We-S2-08 - Christien Steyn, Peter le Roux, Steven Chown, Mark van Kleunen, Wayne Dawson, Marten Winter, Franz Essl, Jan Pergl, Petr Pyšek, Holger Kreft, Patrick Weigelt, Michelle Greve
A biogeographical and functional approach to improve our understanding of alien plant species on Sub-Antarctic Islands
- 16:00 - 16:45 Coffee break

Session 3 *Ecological impacts of biological invasions / Invader traits and characteristics of invaded communities.* Chair: Ingolf Kühn

- 16:45 - 17:00 We-S3-01 - Stefan Linzmaier, Jonathan Jeschke
Mechanisms of exploitation and interference competition in a novel invader – the marbled crayfish
- 17:00 - 17:15 We-S3-02 - William Allen, Sally Street, Isabella Capellini
How life history influences invasiveness across terrestrial vertebrate classes
- 17:15 - 17:30 We-S3-03 - Sabrina Kumschick
Alien species classification and missing data: impact matters

- 17:30 - 17:45 We-S3-04 - Lorenzo Lazzaro, Giuseppe Mazza, Lorenzo Lastrucci, Claudia Giuliani, Alessandra Lagomarsino, Silvia Landi, Giada D'Errico, Elena Tricarico, Roberta Pastorelli, Alberto Inghilesi, Giulia Torrini, Pio Roversi, Arturo Fabiani, Bruno Foggi
Multiple impacts caused by the invasive tree *Robinia pseudoacacia*: insights from soil chemical features to microarthropods, nematodes, microbial and plant communities
- 17:45 - 18:00 We-S3-05 - Colin Orians, Robert Schaeffer, Wilson Claire, Mauri Barrett, Carol Thornber, Evan Preisser
Interacting invasive herbivores on hemlock: Effects on chemistry, growth and phenology
- 18:00 - 18:15 We-S3-06 - Varos Petrosyan, Victor Golubkov, Nikolai Zavyalov, Zoya Goryainova, Natalia Dergunova, Andrey Omelchenko, Sergey Bessonov, Sergey Albov, Natalia Marchenko, Lyudmila Khlyap, Yuri Dgebuadze
The Eurasian (*Castor fiber* L.) and Canadian (*Castor canadensis* Kuhl) beavers in the European part of Russia: long-term population dynamics and interrelationships between the species
- 18:15 - 18:30 We-S3-07 - Marc Kenis
Harmonia axyridis in Europe: have we been too alarmist?
- 19:00 - 20:00 Neobiota Council meeting
- 20:00 - 23:00 Social meeting in cultural café @ Ancien Cinéma café-club

Thursday, 15 September 2016

08:00 - 09:00 Registration @ Foyer

Keynote 2 *Biogeography and macroecology of invasions.* Chair: Philip Hulme

09:00 - 09:45 Th-K-02 - Mark van Kleunen
Pretty, hot and sometimes successful: naturalization potential of ornamental garden plants in a changing climate

Session 4 *Biogeography and macroecology of invasions.* Chair: Philip Hulme

09:45 - 10:00 Th-S4-01 - Noëlie Maurel, Mark van Kleunen
Scaling up from local climate matching in gardens to continental naturalization success: the case of ornamental woody plants in Europe

10:00 - 10:15 Th-S4-02 - Christine Sheppard
Long-term dynamics of plant invasions: the role of residence time in determining invader performance

10:15 - 10:30 Th-S4-03 - Pavel Pipek, Petr Pyšek, Tim Blackburn
Newspaper Stars in Feathers – reconstruction of passerine invasion history in New Zealand

10:30 - 10:45 Th-S4-04 - Belinda Gallardo, Pablo González, Wilfried Thuiller, Petr Pyšek, Montserrat Vilà, Chriss Yesson
Macroecological patterns of Europe's 100 of the worst invasive species under current and future conditions

10:30 - 11:15 Coffee break

Session 5 *Invasive species and changes in landuse / Biogeography and macroecology of invasions.* Chair: Helen Roy

- 11:15 - 11:30 Th-S5-01 - Franz Essl, Wayne Dawson, Holger Kreft, Petr Pyšek, Jan Pergl, Mark van Kleunen, Patrick Weigelt, Bernd Lenzner, Thomas Mang, Dietmar Moser, Stefan Dullinger, Marten Winter
The drivers of the level of plant invasions world-wide
- 11:30 - 11:45 Th-S5-02 - Hanno Seebens, Franz Essl, Bernd Blasius
Patterns and predictions of the global spread of alien species: The intermediate distance hypothesis
- 11:45 - 12:00 Th-S5-03 - Jonas Lembrechts, Jonathan Lenoir, Nina Roth, Tarek Hattab, MIREN Consortium, Ann Milbau, Ivan Nijs
Plant invasions in mountains: improving invasive species distribution models' performances by accounting for the road network
- 12:00 - 12:15 Th-S5-04 - Ana Montero-Castaño, Carolina Morales, Pablo González-Moreno, Montserrat Vilà, Marcelo Aizen
Influential factors across an invasion process: the invasion of the Scotch broom in Nahuel Huapi National Park (Argentina)
- 12:15 - 12:30 Th-S5-05 - Chad Jones
Patterns of plant invasions over 60 years in a developing forest

12:45 - 14:00 Lunch & Poster session

Keynote 3 *Non-native pests and pathogens.* Chair: Wolfgang Rabitsch

- 14:00 - 14:45 Th-K-03 - Alison Dunn
Invasive Alien Species and Pathogens: interactions, impact and strategies for control

Session 6 *Non-native pests and pathogens.* Chair: Wolfgang Rabitsch

- 14:45 - 15:00 Th-S6-01 - Stefan Schindler, Helen Bayliss, Mildren Adam, Wolfgang Rabitsch, Franz Essl, Hans-Peter Hutter, Peter Wallner, Swen Follak, Andrew Pullin
Alien species of human health concern: Evidence syntheses for impacts and management effectiveness
- 15:00 - 15:15 Th-S6-02 - Helen Roy
Exploring the barriers to predicting alien pathogen invasions
- 15:15 - 15:30 Th-S6-03 - Heinke Jäger, Alonso Carrion, Jacqueline Rodriguez, Denisse Barrera, Sabine Tebbich, Arno Cimadam, Christian Sevilla, Charlotte Causton
Restoration of a blackberry-invaded unique forest in Galápagos: impacts on the vegetation, birds and invertebrates
- 15:30 - 15:45 Th-S6-04 - Jennifer Fill, Brian van Wilgen, Johan Baard, Chad Cheney, Aurelia Forsyth, Greg Forsyth, Tineke Kraaij, David Le Maitre
Challenges to invasive alien plant control and ecosystem restoration in the Cape fynbos, South Africa

15:45 - 16:00 Th-S6-05 - Kylie Ireland, Rieks van Klinken, David Cook, David Logan, Lisa Jamieson, Joy Tyson, Philip Hulme, Susan Worner, Eckehard Brockerhoff, John Fletcher, Brendan Rodoni, Gabrielle Vivian-Smith, Rosa Crnov, Mark Whattam, Mandy Christopher, Barbara Hall, Rod Turner, David Teulon. Mike Hodda, Dean Pains
Plant pest impacts: A common set of metrics

16:00 - 16:45 Coffee break

16:45 - 18:30 Poster session @ Poster spaces

20:00 - 22:30 Conference dinner @ Vianden Castle - Vic Abens Room

20:00 - 23:00 Social meeting in cultural café @ Ancien Cinéma café-club

Friday, 16 September 2016

08:00 - 09:00 Registration @ Foyer

Keynote 4 Genetics and evolution of invasive species. Chair: Petr Pyšek

9:00 - 09:45 Fr-K-04 - Carol E. Lee
Evolution of Osmoregulation Arising from Fluctuating Seas, and Implications for Invasions

Session 7 Genetics and evolution of invasive species. Chair: Petr Pyšek

09:45 - 10:00 Fr-S7-01 - Frank Drygala, Alain Frantz
Using genetic tools to inference expansion pattern of the raccoon dog

10:00 - 10:15 Fr-S7-02 - Natalia Osten-Sacken, Mike Heddergott, Martin Runge, Alain Frantz
Using population genetics to understand the evolutionary potential of an introduced parasitic nematode, the raccoon roundworm (*Baylisascaris procyonis*)

10:15 - 10:30 Fr-S7-03 - Marion Javal, Alain Roques, Géraldine Roux
Exploring the invasion history of an exotic pest based on genetic markers: the case of the Asian long-horned beetle (*Anoplophora glabripennis*).

10:30 - 11:15 Coffee break

Session 8 Genetics and evolution of invasive species / Engaging the public with the topic on invasive species. Chair: Ingo Kowarik

11:15 - 11:30 Fr-S8-01 - Tomasz Rewicz, Remi Wattier, Michal Grabowski, Thierry Rigaud, Tomasz Mamos, Karolina Bacela-Spychalska
Out of the Black Sea: Phylogeography of the invasive killer shrimp *Dikerogammarus villosus* across Europe

11:30 - 11:45 Fr-S8-02 - Giovanni Vimercati, Sarah Davies, John Measey
Never underestimate your opponent: adaptive phenotypic response in a recent invader

- 11:45 - 12:00 Fr-S8-03 - Cindy Verdu, Xavier Bouteiller, Emmi Aikio, Kasso Daïnou, Adline Delcamp, Oliver de Thier, Frédéric Gévaudant, Erwan Giuchoux, Yech'an Laizet, Philippe Lejeune, Coralie Mengal, Samuel Quevauvillers, Alexandre Raimbault, Raphaël Ségura, Ludivine Lassois, Arnaud Monty, Stéphanie Mariette, Annabel Porté
A multidisciplinary insight in *Robinia pseudoacacia* genetic and phenotypic diversity
- 12:00 - 12:15 Fr-S8-04 - Xenia Junge, Marcel Hunziker, Nicole Bauer, Arne Arnberger, Roland Olschewski, Daniel Fischer
Public and expert perception of invasive neobiota and development of neobiota communication tools
- 12:15 - 12:30 Fr-S8-05 - Charles Bargerion, Keith Douce, Joseph LaForest, David Moorhead
Smartphones: changing the way invasive species are reported
- 12:30 - 12:45 Fr-S8-06 - Ana Novoa, Susan Canavan, Cathleen Cybèle, Sarah Davies, Paul Downey, Mirijam Gaertner, Sjirk Sjirk, Charles Griffiths, Philip Ivey, Haylee Kaplan, Sabrina Kumschick, David Le Maitre, John Measey, Ana Nunes, David Richardson, Tamara Robinson, Ross Shackleton, Louise Stafford, Julia Touza, John Wilson
Engaging stakeholders on the management of invasive species: a step by step framework

12:45 - 14:00 Lunch & Poster session

Keynote 5 *Eradication, management & control of invasive species.* Chair: Laurent Schley

14:00 - 14:45 Fr-K-05 - Christoph Kueffer
Managing biological invasions in the Anthropocene

Session 9 *Eradication, management & control of invasive species.* Chair: Laurent Schley

14:45 - 15:00 Fr-S9-01 - Heinz Müller-Schärer, Bruno Chauvel, Gerhard Karrer, Gabriella Kazinczi, Per Kudsk, Alfons Oude Lansink, Urs Schaffner, Carsten Skjoth, Matt Smith, Maurizio Vurro, Letty de Weger, Yan Sun, Suzanne Lommen
Cross-fertilizing weed science and invasion science: *Ambrosia artemisiifolia* as an ideal bridge species

15:00 - 15:15 Fr-S9-02 - Suzanne Lommen, Caspar Hallmann, Eelke Jongejans, Heinz Müller-Schärer
Environmental drivers of European-wide variation in *Ambrosia* pollen and seed production, and implications for management of this invasive, allergenic species

15:15 - 15:30 Fr-S9-03 - Janine Saegesser, Daniel Fischer, Kathrin Fischer
Long-term control of *Impatiens glandulifera* in a Swiss Forest: does zero-tolerance pay off?

15:30 - 15:45 Fr-S9-04 - Pablo González-Moreno, Alex Brook, Kate Constantine, René Eschen, Daisuke Kurose, Corin Pratt, Nikolai Thom, Sarah Thomas, Richard Shaw

Making the psyllid work: the biological control of Japanese knotweed in England and Wales as a study system to understand and manage biological invasions

15:45 - 16:00 Fr-S9-05 - Pauline Palmas, Elsa Bonnaud, Raphaël Gouyet, Malik Oedin, Alexandre Millon, Corentin Chaillon, Frédéric Rigault, Jean-Jérôme Cassan, Eric Vidal

How to deal with cat (*Felis silvestris catus*) management on a large and inhabited island?

16:00 - 16:45 Coffee break

Session 10 *Eradication, management & control of invasive species / Biosecurity and risk assessment, including early detection and rapid response.* Chair: Uwe Starfinger

16:45 - 17:00 Fr-S10-01 - Simone Lioy, Marco Porporato, Daniela Laurino, Aulo Manino, Sandro Bertolino

Spread of *Vespa velutina* in Italy: natural diffusion, human-mediated dispersion and monitoring intensity to improve the management activities

17:00 - 17:15 Fr-S10-02 - Spyridon Flevaris

EU Regulation on invasion alien species

17:15 - 17:30 Fr-S10-03 - Montserrat Vilà, Pablo González-Moreno, Marc Kenis, et al. Consistency of impact risk assessments across assessors

17:30 - 17:45 Fr-S10-04 - Sonia Vanderhoeven, Etienne Branquart, Bram D'hondt, Phil Hulme, Assaf Schwartz, Diederik Strubbe, Anne Turbé, Niall Moore, Jim Casaer, Hugo Verreycken, Tim Adriaens

Beyond protocols: improving the reliability of expert-based risk analysis underpinning invasive species policies

17:45 - 18:00 Fr-S10-05 - Katelyn Faulkner, Mark Robertson, Mathieu Rouget, John Wilson Prioritising surveillance for alien organisms transported as stowaways on ships

18:00 - 18:15 Fr-S10-06 - Irene Adrian-Kalchhauser, Patricia Burkhardt-Holm Detection of invasive gobies by probing freshwater samples for DNA traces

18:15 - 18:30 Fr-S10-07 - Katriona Shea, Ciara Hovis, Joseph Keller, Brittany Teller, Ruth Hufbauer

Parsing Propagule Pressure: The effects of multiple aspects of propagule pressure on the success of the invasive musk thistle *Carduus nutans*

18:30 - 19:00 Conference closing

Jan Herr (Poster award), Christian Ries (Organizing Committee), Bruce Osborne (10th Neobiota conference 2018 in Ireland), Montserrat Vilà (Neobiota Consortium).

20:00 - 23:00 Social meeting in cultural café @ Ancien Cinéma café-club

Saturday, 17 September 2016

09:00 - 17:00 Field trip

20:00 - 23:00 Social meeting in cultural café @ Ancien Cinéma café-club

Oral Presentations

Wednesday, 14 September 2016 - 09:45 - 10:30

Keynote 1 - Biological invasions and climate change

We-K-01

Will climate change increase the success and impacts of invasive species?

Cascade Sorte

Department of Ecology and Evolutionary Biology, University of California, Irvine, United States

Climate change and biological invasions are two of the greatest threats to global biodiversity and ecosystem functioning. Both climate change and invasions have, individually, caused population declines and local extinctions of native species. Furthermore, these threats may not be independent, leading to a “double whammy” for native species if they are simultaneously impacted by climate change and invasive species both *directly* and *indirectly*, e.g., via climate-driven increases in invasive species or invasive species impacts on the ability of natives to cope with climate change. In my talk, I address the hypothesis that climate change and species invasions will interact, to the detriment of native species. First, I ask: will invasive species be favored over native species under changing climatic conditions? Secondly, will climate change increase the impacts of invasive species on native species? I draw conclusions from empirical data and results of meta-analyses and syntheses conducted as part of two international, cross-ecosystem working groups. Together, these findings suggest that climate change is likely to increase the success and impacts of many invasive species. However, the threat varies across taxa, ecosystems, and regions, highlighting the importance of localized prevention and management efforts and scope for restoration under future change.

Keywords: climate change, extreme events, impacts, prediction, horticulture, marine, terrestrial

Wednesday, 14 September 2016 - 11:15 - 12:45

Session 1 - Biological invasions and climate change

We-S1-01

Impacts of drought and plant origin on growth and tolerance of the invasive perennial *Tanacetum vulgare*

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Abiotic conditions such as increased drought events expected due to climate change as well as numerous biotic factors, including human activities, potentially select for trait changes in invasive organisms. One of the key hypotheses in invasion biology postulates that invasive plant populations show an increased phenotypic plasticity compared to their native counterparts, which may be advantageous. We investigated how plants of different origin respond in growth, regrowth and various leaf traits to drought. Therefore, we grew 18 populations of the perennial plant *Tanacetum vulgare* with different range expansion (North America, invasive; West Europe, archaeophyte; East Europe, native) in competition with the common grass *Poa pratensis* under two irrigation treatments (dry and control) in a common garden. Aboveground biomass was cut once and regrowth as measure of tolerance evaluated under constant water conditions. The phenotypic plasticity of life-history traits in response to these treatments was determined. The irrigation treatment had only little effect on plant traits of *T. vulgare* in the first growing period. However, at regrowth plants originally exposed to dry conditions grew more vigorously. In contrast, the grass produced less biomass in response to drought before and after cutting, being thus more sensitive to drought. Contrary to our expectations, phenotypic plasticity was not higher in plants of the invasive populations and even reduced in one trait, which may be due to ecological constraints in a complex environment. Several traits such as tolerance differed between plants from different regions, reflecting in part the likely introduction pathway from East to West Europe and from there to North America. Significant effects of latitude, as indicator for climate conditions, on traits were more pronounced in plants of the native origin, whereas in invasive populations, local adaptations may be interfered by genetic admixture. Our study highlights the need to test the responsiveness of plant traits from native *versus* invasive populations in complex environments, including various stress factors. Furthermore, it demonstrates the importance of considering the range expansion and origin of populations as important factors influencing trait expression and plasticity.

Keywords: common garden, competition, phenotypic plasticity, regrowth, terpenoids, tolerance

We-S1-02

Using elevational gradients to understand plant invasions in cold environments: a field experiment in Sweden and Chile.

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Plant invasions into cold environments are a growing threat to biodiversity. Mountains and high latitude environments are becoming increasingly invaded because of higher human-induced propagule pressure and disturbances, and lower climatic barriers due to global warming. Mountains in high latitudes may serve as good natural climatic gradients to understand which are the most relevant drivers of plant invasions into cold environments. We used a multifactorial field experiment to test how human-mediated (i.e. disturbance, nutrient addition and propagule pressure) and climatic factors influence the outcome of an invasion. The experiment encompassed sites in Sweden and Chile to increase the power of generalization. In 1-m² plots located at low, medium and high elevation in three mountains in each study site, we seeded non-native plants known to occur in each region. The experiment included two levels of propagule pressure (5 and 30 seeds), nutrient addition and control (non-addition), and disturbance (removal of vegetation) and control (non-removal). We show how invader success (growth and reproduction) showed a quadratic correlation with elevation. Plants were bigger and more reproductive at mid elevation, which may be due to competition with the surrounding vegetation? at low elevations and cold climate at high elevations. Although Sweden and Chile have very different biogeographic and historical contexts, this pattern was held for both regions. Disturbance turned out to be the main driver of invader success besides elevation, with high nutrient levels playing an additional role in biomass and flower production. At this small scale, the role of propagule pressure was negligible, especially towards later stages of invader development. We thus argue that mountains are likely to see rapid increases in plant invasions in the near future, with temperatures, disturbance and human influence on the rise. Our results suggest that even though climate change is already a reality in cold environments, preventive measures should play an important role by reducing human disturbances in mountains. This research emphasizes the importance of having a global monitoring network of plant invasions in cold environments to inform managers and policy makers about critical decisions to control plant invasions.

Funding provided by the Swedish Research Council (VR 2012-6252) to AM, AP and MAN and by the Research Foundation - Flanders (FWO) to J.J.L. AP funded by grants ICM P05-002 and PFB-23 of the Institute of Ecology and Biodiversity.

Keywords: altitude, biosecurity, global warming, subpolar regions

We-S1-03

Population dynamics of alien plants in a montane ecosystem

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Our knowledge and understanding of population dynamics of invasive species in montane ecosystems is limited, mostly due to a shortage of suitable datasets. An exception is provided by a monitoring project in the Drakensberg, South Africa (Kalwij et al. 2008, Kalwij et al. 2015). This project, running since 2007, showed that alien plant species are ascending at unprecedented rates (annual ascents of 9.7 m/yr for perennials (N = 26) and 24.5 m/yr for annuals (N = 17)). While Kalwij and colleagues collected data from the altitudinal range margin of species, it remains unclear whether species can complete their life cycle in these range margins. This study aims to fill that gap by also collecting data on the life stage of aliens. This enables differentiating between the core altitudinal distribution range (i.e., where species can complete their life cycle) and the altitudinal periphery of species ranges. The current monitoring protocol prescribes recording the three highest altitudinal observations of each alien species in the verges of the Sani Pass road, along an altitudinal gradient of 1,500–3,200 m a.s.l. We complemented this protocol with the highest altitudinal observations of flowering and seed-producing alien plants in January and March 2016. We found 84 exotic plant species, 63 of which were observed with seeds. For annuals, highest observed individuals were at significantly higher altitudes than flowering individuals by 104.5 m ($t = 2.476$, $df = 35$, $P = 0.018$), but there was no difference between flowering and seed-bearing plants ($t = 1.671$, $df = 34$, $P = 0.104$). For perennials, however, there was no significant difference in altitude between either of the life cycle stage pairs. These results show that exotic species can complete their life cycle even at very high altitudes, suggesting that their ecological range margin is relatively small. An altitudinal range shift, whether due to climate change or in response to anthropogenic disturbance, would therefore have a significant effect on the impact of exotic species in montane ecosystems.

Keywords: established range; potential range; range edge; Sani Pass; South Africa

Successful Adaptations to Adverse Environmental Conditions: More Areas under the Risk of Ragweed Invasion?

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Common ragweed (*Ambrosia artemisiifolia* L.) is an allergenic plant currently invading considerable portion of Europe. The species distribution modeling indicates that temperature will be the most limiting factor for the further spread of ragweed in Europe. Although climate predictions estimate that aridity and salinity will globally increase in the coming decades, abiotic stresses such as drought and salinity have rarely been considered in modeling the potential spread of the plant. In the current study seedling survival, growth and nutrient uptake of ragweed were tested under five available water contents (100, 75, 50, 25 and 12.5% available water based on field capacity) and four soil salinity levels (0, 3, 6 and 12 dSm⁻¹) in greenhouse experiments. Experiments were conducted according to a randomized complete block design with 5 replications. The results indicated that all the transplanted seedlings successfully survived under the experimental conditions tested except severe water deficiency (12.5% available water) and the highest level of salinity (12 dSm⁻¹). The growth and reproductive outputs of the plant were decreased with increasing water deficit and salinity level. However, all surviving plants have produced seeds. A sharp decline in reproductive output of the plant was observed under 25 and 12.5% available water treatments, and 6 and 12 dSm⁻¹ salinity levels. The ragweed used different strategies to cope with adverse environmental conditions such as increased uptake of K, maintained higher K/Na and root-to-shoot ratios and early flowering. It is concluded that ragweed can successfully adapt to changing climate and expand its range in the currently invaded regions. Local populations adapted to low water availability and high salinity levels may cause severe problems in natural and agricultural ecosystems. However, further studies on the genetics of stress tolerance are needed to identify the genes and mechanisms behind the increased tolerance of ragweed to adverse environmental conditions.

This study was funded by TUBITAK with grant number 113 O 790 as a part of Cost Action TD-1209. The results also address the major challenges focused by Cost Action FA-1203

Keywords: Common ragweed, abiotic stress tolerance, growth, invasion

We-S1-05

Slug invasion and climate change: phylogenetics, interception records and climatic niche help elucidate global spread of *Arion* species

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Global trade increases the rate of biological invasions, which are causing severe problems to native ecosystems. It is therefore important to establish the routes of invasive species introduction if we are to prevent new ones. The situation might be exacerbated by climate change, which can influence the suitability of climatic conditions for the invasive species, often by increasing the amount of suitable locations. However, the opposite situation could also occur, even though this has not been reported very often. Here, we focus on three *Arion* slug species introduced to Northern America and Australia, for which the potential for global spread has never been assessed. We combined interception records, genetics and species distribution modelling to assess their introduction history and to predict which regions are of the highest risk of future invasions. We examined the genetic diversity within samples and geographic regions with two mitochondrial DNA markers. We also inferred the worldwide potential distribution of *Arion* sp. under current climatic conditions and two future timeframes using climate change scenarios and an ensemble of four different modelling techniques. We found extensive haplotype sharing among continents, and evidence of anthropogenic movement within the area of introduction. In concordance with the genetic analyses, interception records suggest that these slugs get introduced to the USA and Australia primarily from France, the Netherlands and the UK, but also from other locations in North America. Surprisingly, under the future climate scenarios, the amount of regions with suitable environmental conditions for the three species is likely to decrease and shift towards the North. However, given the potential significant impact of this invasion, the efforts to prevent new introductions should not be ceased.

Keywords: invasive species, molluscs, species distribution modelling

Insect invasions under climate change: an agroecological perspective

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Climate change affects the rate of insect invasions as well as the abundance, distribution and impacts of such invasions on a global scale. Among the principal analytical approaches to predicting and understanding future impacts of biological invasions are Species Distribution Models (SDMs) and other forms of niche models. One niche modelling approach, the semi-mechanistic platform CLIMEX, is able to employ information on ecophysiological traits, abundance data and observed distributions to model the species relationship with climate. This combination of inductive and deductive methods to fit model parameters allows CLIMEX to avoid some of the issues of extrapolation which are a major pitfall of correlative based SDMs. CLIMEX is therefore highly applicable to investigating biological invasions in the context of climate change.

The tephritid fruit flies (Diptera: Tephritidae) comprise some of the most successful invasive species and serious economic pests around the world. As such there have been numerous modelling attempts for a number of particularly injurious species. Here we collate individually parametrized CLIMEX models from the literature for 12 tephritid species. We project these models into both present and future climate scenarios to examine overall patterns of climate suitability and forecast potential global distributional changes for this group. We further compare the aggregate response of the group against species-specific responses. Climate change is predicted to decrease global climate suitability and to shift the cumulative distribution poleward for the group of tephritid species examined here. However, when examining species-level patterns, the predominant directionality of range shifts for 11 of the 12 species is globally eastward, resulting in different degrees of species turnover at a regional level.

Whilst it is a relatively straight forward exercise to produce such maps of global distribution patterns, disconnect exists between predicting changes in invasion potential and providing management options for farmers. We explore how indices relating to trade and fruit production can be used to help understand patterns of risk and then then discuss future directions for how maps of invasion potential may be made useful to inform management strategies both now and under future climate change.

Keywords: Climate change, Trade, Food security, Fruit flies, Tephritidae, Species distribution modelling

Wednesday, 14 September 2016 - 14:00 - 16:00

Session 2 - Invader traits and characteristics of invaded communities

We-S2-01

Early Growth and Development as a Key Defining Feature of Plant Invasions

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Despite more than two decades of investigation the trait(s) associated with successful plant invasions remain largely elusive. Although there is evidence that some traits may be important for plant invasions many may be context-specific making generalisations difficult. There is increasing evidence, however, that early growth and development could be a defining characteristic of plant invasions. Plant invaders can initiate growth and development up to three weeks before resident species and there may be at least three ways to achieve this. Growth is either initiated in the autumn ‘window’ and plants over winter in a semi dormant state subsequently initiating growth the following year and/or the development of storage reserves during the autumn provide resources for earlier development in the spring ‘window’. For annual invaders that complete their life cycle in the same year growth and development appears to occur without a reliance on stored reserves but occurs rapidly after seed germination. A key feature of these strategies is that the acquisition of limiting essential resources, such as nitrogen and water, to support early leaf growth and development, is possible under sub optimal environmental conditions, and that growth is largely photoperiod-insensitive with little or no chilling requirement. A largely temperature-related control of the early initiation of growth and development may also explain why invasive plant species often exhibit a greater response to climate change-related factors, particularly the increased length of the growing season. In contrast, a high maximum growth rate during early season growth appears to be less important. Whilst there are several examples of early growth in introduced species there are few comparative examples where any benefits can be directly assessed, although data on the contrasting invaders cheat grass (*Bromus tectorum*) and *Gunnera* is consistent with advantages associated with early growth and an ability to acquire limiting resources under sub-optimal conditions. The recognition that early growth and the exploitation of a period when plant-plant interactions are low may also explain the often equivocal evidence for invasive plant species having a superior competitive ability. What is puzzling, however, is why resident species initiate growth later, unless this strategy has proved more successful in the longer-term.

Keywords: early growth, resource-use, sub-optimal conditions, *Gunnera*

Germination strategies and plant invasions: current knowledge, gaps and challenges

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Germination patterns strongly affect the fitness and survival of a plant, its evolutionary potential, and the timing of competition among neighboring individuals/species. To improve our understanding of their significance in plant invasions, we synthesize the findings of studies examining a range of germination patterns (time to germination, germination rates, and germination percentages/ratios), under a range of environmental conditions. These patterns were compared for (1) invasive alien and non-invasive alien congeners, (2) invasive alien species and native species/congeners, (3) invasive and non-invasive congeners in their native range, and (4) invasive species in their native and non-native range. Experimental evidence indicates that invasive species germinate consistently earlier and more rapidly (lower time to germination and higher germination rates) compared to non-invasive congeners and co-occurring native species in their non-native range. Moreover, invasive species germinated consistently earlier or more rapidly in their non-native range, although the role of adaptation, plasticity or genetic variation in determining such patterns has been rarely assessed. Pre-adaptation resulting in earlier/rapid germination was also reported as an important factor in the naturalization or invasiveness of several species. In contrast, germination percentages (final or 50% germination) were higher, similar or even lower for invasive species compared to non-invasive or less invasive congeners, or to native species/congeners, suggesting that a high germination percentage is not a reliable predictor of invasiveness. The generality of these patterns and the need for additional observational and experimental studies, focusing on germination as a crucial stage in the naturalization and persistence of invasive species, are discussed.

Keywords: dormancy, germination, invasiveness, invasibility, soil seed bank

Mycorrhizal status interacting with morphological traits help explaining invasion success of alien plant species

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It is still debated whether alien plants benefit from being mycorrhizal, or if engaging in the mycorrhizal symbiosis constrains their establishment and spread in new regions. Here, we analyzed the association between mycorrhizal status of alien plant species in Germany and their invasion success. We compared whether the representation of species with different mycorrhizal status (obligate, facultative or non-mycorrhizal) differed at several stages of the invasion process. Furthermore, we used generalised linear models to explain the range in Germany, incorporating interactions of mycorrhizal status with additional plant traits related to morphology, reproduction, and life-history. Non-naturalized aliens did not differ in their relative frequency of mycorrhizal status from naturalized aliens. Mycorrhizal status significantly explained the occupied geographical range, with facultative mycorrhizal species occupying a larger range than non-mycorrhizal aliens and obligate mycorrhizal plant species taking an intermediate position. Additionally, aliens with storage organs, shoot metamorphoses or specialized structures promoting vegetative dispersal on the expense of high carbon and energy demand, occupied a larger range if being facultative mycorrhizal. We conclude that being mycorrhizal is important for the establishment and persistence of aliens in Central Europe and constitutes an advantage compared to non-mycorrhizal plants. Being facultative mycorrhizal seems to be especially advantageous for successful spread, as the flexibility of this mycorrhizal status may lead to a broader set of ecological strategies. Still it seems that facultative mycorrhizal neophytic species benefit from trade-offs with other traits related to high carbon cost, such trade-offs are almost absent from natives. This indicates that natives and neophytes benefit differently from the symbiosis and that the benefits received by natives are independent of carbon allocation.

Keywords: alien plants, biological invasion, Central Europe, floristic status, functional traits, MycoFlor, mycorrhizal status, trait interactions

One ring rules them all: genome size as a driver of invasiveness in plants

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The ecological role of genome size in plant invasion research has garnered increasing attention with the rapid development of screening methods and technology associated with measuring cytological characteristics. Knowledge gained from studies analyzing large numbers of species suggests that (i) across angiosperms, small genomes are disproportionately over-represented in invasive taxa. (ii) Within the subset of 128 globally most invasive species there was a higher frequency of species with very small genomes and a lack of large genomes among invasives, compared with their non-invasive congeners (Suda et al. 2015). (iii) Invasiveness is negatively correlated with genome size but positively with ploidy level, and it is their interaction that underlies their actual effects on invasion success (Pandit et al. 2014). (iv) If stages of invasion are taken into account, small genome seems to be an attribute of naturalized, not necessarily invasive congeners within the pairs they formed with non-invasives (Kubešová et al. 2010).

In this paper, we discuss the above results, but we also present the first study that explores the role genome size in promoting invasiveness in a framework that fundamentally differs from the multi-species studies in (i) focusing on differences in monoploid genome size at the population level, (ii) testing how the effects of genome size hold in interactions with other plant traits. To address these issues, we studied multiple factors assumed to affect plant invasiveness in a grass species *Phragmites australis*. In a common garden experiment, we grew native and invasive populations from Europe and North America for three years under standardized conditions, and measured a wide range of plant traits related to demography and population dynamics, herbivory, physiology and karyology. Several important variables were most relevant for the classification of invasive vs non-invasive populations based on the random forest algorithm: monoploid genome size, below- and above-ground biomass ratio, number of shoots, rhizome length and biomass, seasonality of climate in the region from which the population was sampled, and herbivory by aphids. However, the decision tree identified monoploid genome size as the only important variable separating invasives below the 1Cx-value of 0.53 pg. That genome size is retained as one of the most important factors also in a complex model including other factors potentially affecting invasiveness is an important finding providing strong support for exploring genome-size research avenue in plant invasions.

Keywords: population invasiveness, genome size, *Phragmites australis*

Phylogenetic novelty alters the strength of biotic interactions for native and exotic plant species

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Patterns of phylogenetic relatedness within communities have been widely used to infer the importance of different ecological and evolutionary processes during community assembly and invasion processes. Novel exotic plants are expected to have less niche overlap with resident plant species and have novel defense traits. Therefore, the population dynamics of exotic plant species are expected to be less influenced by competitors and enemies. However, novel exotic plant species might also interact less strongly with resident mutualists, and this is expected to reduce the observed population growth rate of exotic plant species. Finally, it is expected that closely related native and exotic plant species will have similar strengths of biotic interactions and population dynamics, but this idea has not been thoroughly evaluated. While many studies have examined the relationships between phylogenetic novelty (or functional trait novelty) and invasiveness of exotic plant species, much fewer have examined the mechanisms that might underlie these patterns. Here we provide a comprehensive test of the relationship between phylogeny, the strength of biotic interactions, and population dynamics for eight exotic and three native plant species occurring at a single field site near St. Louis, Missouri, USA. We collected demographic data for each plant species and projected per capita growth rates under the following experimental treatments: above-ground competitor removal, above-ground insect herbivore removal, below-ground fungi removal, below-ground insect herbivore removal. We found the strongest correlation among phylogenetic relatedness and competitor removal, in a way that more closely related species benefited more strongly from release of aboveground competition compared to novel (distantly related) species. The effects of other treatments were more idiosyncratic, being highly important for one or two plant species but not showing general effects or patterns with phylogeny. This result indicates that more novel species compete less strongly with resident species in the community, and highlights the importance of competitive interactions for community and invasion dynamics.

Keywords: Darwin's Naturalization Hypothesis, competition, demography, functional traits, phylogeny, population projection modeling

We-S2-06

Linking divergence and dissimilarity in native and alien species traits to address invasions of plant communities

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A frequent question in plant ecology is whether the traits of alien plant species differ from natives and what underpins trait similarity or difference. This question has increasingly been addressed at the plant community scale and linked to broader theory regarding the role of trait convergence and divergence on community assembly, limiting similarity and habitat filtering.

While superficially similar, trait convergence and divergence are not equivalent concepts to trait dissimilarity. Trait divergence and convergence addresses attributes relating to the distribution of traits within assemblages of co-occurring species (overlap and variance) while trait dissimilarity tests for differences among groups of species (mean or median). Quantitative examples from the literature are re-analyzed to highlight how the failure to make this distinction in trait comparisons of co-occurring alien and native plants hinders the integration of biological invasions within a plant community context.

This distinction is critical since the extent of trait convergence or divergence within native and alien assemblages is essential to place trait dissimilarity into a community context, since it may highlight whether aliens are exploiting regions of trait space unfilled by natives. Assessment of trait dissimilarity solely through comparisons of differences in trait means and variances between native and alien species may miss critical differences in trait convergence and divergence that might shed light on community assembly. A series of schematic models are presented to highlight the need to distinguish between trait divergence and dissimilarity. The extent to which these map on to real-world examples is discussed.

To address these limitations, community approaches need to quantify the distribution of a priori identified traits within communities along suitable gradients and test hypothetical trait patterns against appropriate null models. The infrequent application of such approaches may explain the limited generalizations regarding the drivers and consequences of plant invasions at the community scale. Plant invasions are dynamic processes where the trait distributions of both alien and native species may be expected to change over time through competitive exclusion as well as contemporary evolution. Repeated surveys of both species abundance and their traits are required to predict the consequences of trait dissimilarity and divergence between aliens and natives for plant community assembly.

Keywords: assembly rules, coexistence, CSR, exotic, invasion ecology, limiting similarity, niche difference, SLA, weed

Functional trait differences between native and invasive species across six habitats in the Czech Republic

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Invasive species may be invasive because they are similar to native species or alternatively they may be invasive by exploiting a separate niche. Here we investigate the relationship between plant invasion status (Native, Naturalized or Invasive) and species traits using a countrywide data from the Czech Republic. The data set contains 5950 species of which 4984 are classified as native, 784 are classified as naturalized (non-native but not spreading) and 182 are designated as invasive (non-native and spreading). Each species in the data set was matched with species level plant functional traits. We focused our analyses on three life history traits: height, specific leaf area (SLA) and germinule weight because these traits encapsulate three independent axes for plant life history evolution (Westoby 1998). The species data was further broken down into six unique habitats: grassland, ruderal, scree, wetland, scrub and forest. Our analysis of single traits indicated that invasive species were significantly different for both height and germinule weight in 5 of 6 habitats but for only 2 habitats for specific leaf area. The direction of the difference was only consistent for height data; when significant, invasive plants were taller than native plants. To examine life history strategies and potential trade-offs, we combined the trait data into a multi-dimensional niche index using non-metric multidimensional scaling (NMDS) and subsequently analyzed the distance between the native multi-dimensional trait index and the invasive multi-dimensional trait index using a cumulative density function that measured the distance of the invasive NMDS from the centroid of the native NMDS trait space. Using this more integrated measure, we find that five of six habitats show that the invasive species trait space occurs farther away from the center of the native species centroid trait distribution than expected by chance; further, the only non-significant habitat, wetlands, followed the pattern but was not statistically significant. Thus it appears that that invasive species occupy a multi-dimensional trait space at the outer edge of the native trait space trait space; this occurrence at the boundary of the niche space implies that invasive species are successful because they are beating the native species at their own game, rather than exploiting a unique strategy.

Keywords: invasive, native, naturalized, life history theory, Czech Republic, habitats

A biogeographical and functional approach to improve our understanding of alien plant species on Sub-Antarctic Islands

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As alien species continue to spread across the globe, they increasingly threaten native biodiversity. In isolated island systems, especially on those where native species diversity tends to be low, alien invasions particularly pose a risk to native species. With human assistance aliens are even reaching climatically harsh environments, invading higher altitudes and higher latitudes. The Sub-Antarctic Islands (SAIs) are little influenced by human development and disturbance; however, humans remain responsible for substantial amounts of propagules reaching these areas. This has led to over 300 alien plants establishing across the 21 SAIs, of which 28 have been reported to be invasive on single or multiple islands. To mitigate future invasions, understanding and predicting the potential of aliens becoming invasive in the Sub-Antarctic is thus essential.

Here we use a climate matching approach to predict which plant invaders around the globe have the potential to establish on the SAIs if they were to reach the islands. We obtained a list of over 13000 plant species, which have become naturalized or invasive somewhere in the world, from GloNAF and the Global Invasive Species Database. Occurrence data for all species were extracted from GBIF and a species distribution modelling approach (BIOCLIM) used to establish whether the climate envelope of the alien species overlaps with the climatic conditions of the SAIs. We were able to identify 19 species that pose a potential high risk if introduced. Although climate matching is an important and cost-effective precursor to prevent alien species establishment, it is still not enough to fully understand invasion potential in the Sub-Antarctic. We thus also took a comparative trait-based approach, identifying the key characteristics that differentiate successful invaders from non-invasive aliens. The comparisons were performed by grouping species currently on the island with those species modelled to have a high, medium and low probability of occurring on the SAIs. This is a novel approach for the Sub-Antarctic and will benefit the research community working towards a better understanding of the biogeography and functional characteristics of successful alien species.

Keywords: Biogeography, Distribution Modelling, Functional traits, Invasion potential, Island invasions, Plant invasions, Sub-Antarctic Islands

Wednesday, 14 September 2016 - 16:45 - 18:30

Session 3

Invader traits and characteristics of invaded communities

Topic continued from previous session

We-S3-01

Mechanisms of exploitation and interference competition in a novel invader – the marbled crayfish

Stefan Linzmaier^{1, 2, 3}, Jonathan Jeschke^{1, 2, 3}

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The capability to adapt to new or novel resources is key for the success of introduced species. In particular, differences in foraging parameters between resident and introduced predators can determine the establishment success of introduced predators and their effects on the resident community. We investigate such differences, thereby also looking at the link between predator functional responses and behavioural traits, which is largely unexplored. As model organisms, we focus on freshwater crayfish which had major impacts on recipient ecosystems worldwide. The marbled crayfish (*Procambarus fallax* forma *virginalis*) is a potentially upcoming invader and reproduces parthenogenetically, which is unique for decapod crustaceans. We compared marbled crayfish in a quantitative trait analysis with a species-archetype that is already present in many communities and exhibits comparable traits and a similar ecology: the spiny-cheek crayfish (*Orconectes limosus*). We predicted interaction outcomes and derived expected community changes by comparing behavioural traits and functional responses of these two species. We investigated which predation parameters between the two species differ, how individuals differ in these parameters, and whether the parameters are connected to their functional response. To examine how behaviour mediates the interaction between two species and how individual behaviour and eco-evolutionary experience influence foraging behaviour, we quantified traits that determine key interspecific interactions (e.g. aggressiveness) underlying the invasion success of non-indigenous crayfish. These results were related to the individual functional responses to fathom the relationship between behaviour, predation parameters and the functional response.

Keywords: functional response, behavioral type, personality, competition, community ecology, invasive crayfish

We-S3-02

How life history influences invasiveness across terrestrial vertebrate classes

William Allen^{1,2}, Sally Street², Isabella Capellini²

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Competing theoretical models of how life history influences population growth disagree on whether species with fast or slow life history traits should be advantaged in biological invasions. Species with a fast life history strategy may have an advantage because they can rapidly increase in numbers, limiting the period of increased vulnerability to stochastic events. Alternatively, species that employ a slow strategy may generally be more successful because their populations have reduced variance in vital rates in response to stochastic events. We test these competing predictions using global-scale comparative analyses of hundreds of species of mammals, reptiles and amphibians. Outcomes are tracked throughout the invasion pathway from introduction through establishment and spread. Using the largest database of life history traits yet assembled, invasion success or failure at each stage is associated with multiple life history traits to determine exactly how life history promotes invasiveness. We find that, in addition to dramatic biases in the life history traits of species humans introduce, there is a clear advantage for species with fast life history traits to establish and spread in amphibians, reptiles and mammals. This supports models that emphasize the importance of potential for rapid population growth in favourable conditions. Results contrast with studies of birds, where instead division of reproductive effort into many attempts seems to be key. We suggest that this difference can be attributable to birds' relatively long reproductive lifespans, creating potential for alternative population survival and growth strategies such as bet-hedging, storage and buffering. Results could be used to screen new introductions for species with life histories that have the highest invasion potential.

Keywords: life history traits, invasiveness, amphibians, reptiles, mammals, species prioritization, comparative methods, introduction biases

Session 3

Ecological impacts of biological invasions

We-S3-03

Alien species classification and missing data: impact matters

Sabrina Kumschick

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Invasive Species Programme, South African National Biodiversity Institute, Claremont, South Africa

Alien species can cause a broad range of changes to the recipient environments. Classifying alien species according to the magnitude of impact caused can inform management decisions and aid the protection of native biodiversity. A generic impact scoring system which enables to compare highly diverse impact metrics between taxa has been developed for this purpose. It includes impacts caused through various mechanisms, ranging in intensity from Minimal to Massive depending on the level of organization affected in the recipient environment (individuals, populations, communities, ecosystems). The classification of aliens according to this system relies on primary impact data collected on the focal species in the field. We reviewed different strategies, including specific experimental approaches and observational methods, for detecting and quantifying the ecological impacts of alien species. Our synthesis points out that different experimental methodologies are appropriate for different taxa due to particular properties of the species and ecosystems involved, even though most methods are theoretically possible for most organismal groups. Our recommendations to conduct experiments on impact include a four-way-plot experimental design (uninvaded, invaded, removal of natives, removal of aliens) – not only to reveal ecological and potentially irreversible impacts, but also to determine the potential success of restoration efforts. Furthermore, we identify hypothesis-driven parameters that should be measured at invaded sites to maximize insights into the nature of impact. Our recommendations aim at providing a basis for developing systematic quantitative measurements to allow comparisons of impact across alien species, sites and time, and to maximize the usefulness and outcomes of impact studies, also with regards to a generic classification system for alien species.

Keywords: Impact assessment, risk, management, Environmental Impact Classification of Alien Taxa

Multiple impacts caused by the invasive tree *Robinia pseudoacacia*: insights from soil chemical features to microarthropods, nematodes, microbial and plant communities.

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The Black Locust *Robinia pseudoacacia* (BL) is a nitrogen-fixing tree belonging to the family *Fabaceae*. It is nowadays widespread and naturalized in Europe, temperate Asia, Australia, New Zealand, northern and southern Africa and temperate South America. This plant is an aggressive invader often spreading and replacing native forest formations in the invaded areas. Its ecological impacts are well-known, spanning from the decrease in native species richness and the functional shift of the invaded communities to the biotic homogenization of the understory vegetation and lichen communities. The effects of BL on native communities are mainly caused by an increase in nutrients availability associated with the nitrification of invaded soils. However, the studies on the effects of BL are often focused on few response variables, while more composite approaches, assessing the effects of the invasive plants on several response variables, are required. In particular, studies evaluating the impacts on the soil fauna and microbes are urgently demanded, given their importance in the invasion development and restoration process. The present study evaluates the impacts on soil chemical properties, soil microbial, nematodes, microarthropods and understory plant communities after the invasion of BL in a Central Italy in a comparison between uninvaded and invaded stands. To this end, soil and vegetation samplings were performed in stands invaded by *R. pseudoacacia* and native stands, represented by deciduous oak forests. As expected we detected qualitative and quantitative changes in all the components we analyzed, starting from the well-known soil nitrification and increase in soil nutrients, linked also to the soils acidification. In the invaded stands, species richness and abundance were found to be lower for plant communities, microarthropods and nematodes, while we detected an increase of richness for bacterial communities. In addition, a crucial functional shift was detected particularly for plants and for microarthropods communities. The index of Biological Quality of Soil indicates that microarthropods communities in invaded stands are poorer and less structured than those in native ones. All these data

confirm that BL transforms several components of the invaded ecosystems, modifying the plant-soil community and affecting biodiversity at several levels.

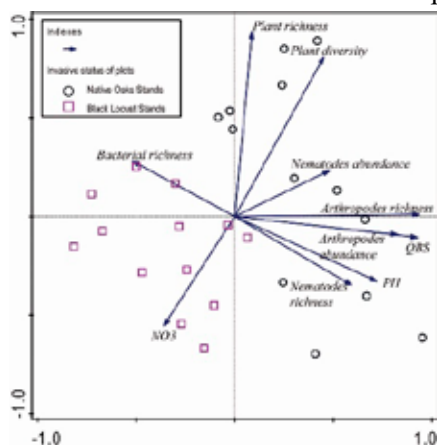


Figure Caption. PCA ordination diagram of sample plots and biotic and abiotic indexes varying significantly across invasion status. QBS = index of Biological Quality of Soil based on microarthropods community.

Keywords: QBS, species richness, species abundance, nitrification, alien

Interacting invasive herbivores on hemlock: Effects on chemistry, growth and phenology

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Introduction:

Eastern Hemlock, *Tsuga canadensis*, is a shade-tolerant foundational tree species in eastern North America that is attacked by two invasive insects: hemlock woolly adelgid (HWA, *Adelges tsugae*) and elongate hemlock scale (EHS, *Fiorinia externa*). HWA, with minimal infestation, can reduce growth in a matter of weeks and, as densities increase, cause mortality in just 4 years. EHS's impact is more benign and can potentially ameliorate the effects of HWA when both co-infest the same host. Here, we show that the two species differ in their effects on hemlock chemistry and growth, and present new evidence that the two species have dramatically different effects on spring new flush initiation (leaf-out) and production. This has large implications for the long-term health of understory saplings that rely on early spring carbon fixation for maintenance and for the production of new growth each.

Methods/results:

Hemlock saplings were planted in the field under a deciduous forest canopy, infested with HWA, EHS, or neither insect, and harvested after four years. Needles from HWA-infested trees had higher nitrogen, a pattern consistent with nutrient manipulation by the insect. HWA also affected traits associated with carbon gain. Rates of photosynthesis were lower, HWA-infested trees had ~15% less biomass aboveground, and the needle to ratio was ~20% lower than in control trees. The reduction in needles appears to be due to both reduced growth and premature needle loss. In addition, the production of new flush foliage in HWA-infested trees was delayed and one-third that of control trees, suggesting that HWA infestation limits the ability of hemlocks to maximize early spring carbon gain prior to hardwood leaf-out. In contrast, EHS-infested trees showed little difference in chemistry, leaf production or in the timing of bud break and production of new-flush foliage.

Conclusion:

Adelgid-induced delays in bud break and decreases in new foliage production, in concert with the accelerated bud break of co-occurring hardwoods due to climate warming, may threaten early-spring and future resource gain in hemlocks. Since EHS has virtually no impact, our previous work showing that EHS deters HWA, suggests that the presence of EHS may be critical to the trees long-term survival in eastern North America.

Keywords: hemlock, understory, sapling, invasive insect, direct effects,

The Eurasian (*Castor fiber* L.) and Canadian (*Castor canadensis* Kuhl) beavers in the European part of Russia: long-term population dynamics and interrelationships between the species

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The results of population dynamics analysis for two beaver species are presented with the help of two different models. The first model (one-species) is designed for population dynamics analysis of Eurasian beaver (*Castor fiber* L.) after its reintroduction into Laplandskiy, Darvinskiy, Central-Forest, Prioksko-Terrasnyi, Okskiy and Khoperskiy reserves, located in the northern, southern and central parts of the species range in European Russia. An analysis of the effectiveness of a discrete-time species-habitat relationship model (active, potential, degraded habitats) was provided for the quantitative description of the population dynamics in optimal, suboptimal and pessimal beaver habitats by the use of long-term monitoring data for the years 1934-2015. It has been demonstrated that population dynamics of Eurasian beaver could be described with the use of 4 types of models: irruptive (Laplandskiy Reserve); single-stage with a quasi-periodic oscillation (Prioksko-Terrasnyi Reserve), two-stage with quasi-periodic oscillations (Darvinskiy, Central-Forest, and Khoperskiy reserves) and logistic trend of the population number change with the periodic oscillations around it (Okskiy Reserve).

Canadian beaver (*Castor Canadensis* Kuhl) invaded Karelia and Leningrad Oblast of Russia in the early 1950s (Danilov et al., 2007). In recent years, Canadian beaver has invaded Arkhangel'sk Oblast, the places previously inhabited by Eurasian beaver. At the same time, the replacement of Canadian beaver by Eurasian beaver in southern Karelia has been observed (Danilov et al., 2015). However, to date the nature of this replacement has been unclear. We hypothesize that between similar species could be a competition for habitat and food resources. We created the second discrete-time model (two species) in order to predict population dynamics for two species when both species use the same food resources. The estimates of the model indicate the replacement of Eurasian beaver by Canadian one for the territories of all studied reserves. However, the duration of this process depends on the initial population number of two species and their fertility characteristics, and varies from 75 to 150 years for different environmental conditions.

Data collection on the territory of the reserves was supported by RFBR grants 15-04-06423, 15-29-02550; mathematical models of population dynamics were developed with financial support of Russian Science Foundation grant № 16-14-10323.

Keywords: alien species, *Castor fiber*, *Castor canadensis*, mathematical model, competition, competitive exclusion, invasion

We-S3-07

***Harmonia axyridis* in Europe: have we been too alarmist?**

Marc Kenis

CABI, Delemont, Switzerland

Since the first feral populations of the harlequin ladybird, *Harmonia axyridis*, were found around the year 2000 in Germany and Belgium, it became one of the most studied invasive alien species in Europe. From the beginning, and based on earlier observations on its invasion in North America, it was considered as a potentially very serious invader, for various reasons. First, it is a human nuisance that aggregates in very high numbers in buildings for overwintering. Secondly, it also aggregates on fruits in autumn and can taint wine when harvested and crushed with grapes. However, it was its potential ecological impact on prey and other aphidophagous predators that raised the most alarming concerns. Hundreds of native species were potentially endangered. Indeed, in the first years of its invasion, it rapidly spread to most European countries and alerted the general public because of its aggregation habits. It was also found preying on a large number of aphidophagous species, mainly ladybirds, and several studies indicated that indigenous ladybird species were declining. However, less than 20 years after the beginning of the invasion, people have become used to have ladybirds visiting their home every autumn, the beetle has never tainted any wine in Europe and, more important, recent studies suggest that only one indigenous species, *Adalia bipunctata*, has strongly declined (but remains rather abundant in some habitats). Similar observations are presently being made in North America. So, have we been too alarmist? Why has this species attracted so much concern compared to other invasive species that are economically and ecologically much more important? The presentation will also discuss the danger of over-emphasizing the impact of flagship invasive species, without forgetting to mention that *H. axyridis* provided a wonderful model species for studying insect invasion biology and ecology, fostering the discipline in Europe and being the inspiration for global collaborations at various scales.

Keywords: *Harmonia axyridis*, ecological impact, invasive ladybirds

Thursday, 15 September 2016 - 09:00 - 09:45

Keynote 2 - Biogeography and macroecology of invasions

Th-K-02

Pretty, hot and sometimes successful: naturalization potential of ornamental garden plants in a changing climate

Mark van Kleunen

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Over 13,000 vascular plant species have become naturalized somewhere in the world. With over 46,000 species grown as ornamentals in private gardens and over 150,000 species in botanical gardens around the globe, ornamental horticulture is the major introduction pathway of alien plants. Indeed, more than 50% of the global naturalized flora is known to be grown in private gardens, and more than 90% of the global naturalized flora is grown in botanical gardens. Although this does not necessarily mean that these gardens are the actual sources of these naturalized species, it nevertheless indicates that gardens are a huge potential source for naturalized and invasive plant species. Ornamental garden plants, therefore require more attention in invasion biology.

Ornamental garden plants provide a unique system to study the potential drivers of plant naturalization and invasion for several reasons. First, for some regions, we have through the works of historian's information on the year of introduction, as well as proxies of planting frequencies for many ornamental plant species. Second, for many ornamental garden plants, we have information on their traits from garden-plant encyclopedia. Third, as many ornamental garden species have not managed to naturalize, at least not yet, we have data on non-naturalized introduced aliens to which we can compare the naturalized ones.

In this presentation, I will report on some of the recent studies from my lab and collaborators on determinants of the naturalization success of ornamental garden plants. As expected, we could show that time since introduction into gardens and planting frequency are positively related to current naturalization success. Despite recent reports of changes in climatic niches of invasive species, we showed that climatic suitability is another important driver of naturalization success. With regard to species traits, we found fewer consistent relationships with naturalization success. However, we found evidence for interactions between different traits and between traits and climatic suitability on naturalization success, thereby providing empirical evidence for the frequently claimed context dependency of traits. Moreover, using path analysis, we could show that certain frequently observed associations between species traits and naturalization success might reflect an introduction bias. In other words, we found that species with certain traits were introduced earlier and more frequently than others, and that this earlier introduction and high planting frequency promoted naturalization.

The strong effect of introduction history on naturalization success implies that with time, and possible changes in planting frequencies, many of the currently non-naturalized ornamental species pose a naturalization debt. Furthermore, given the strong association between climatic suitability and naturalization success, we might expect that with ongoing climate change, a new generation of naturalized species will emerge from our gardens. Therefore, I will finish my presentation with the first results of our BiodivERsA project WhoIsNext, in which we address

with modelling and experimental studies which ornamental garden species might be the invaders of the future.

Keywords: invasive alien species, horticulture, ornamental garden plants, naturalization, climate change

Thursday, 15 September 2016 - 09:45 - 10:30

Session 4 - Biogeography and macroecology of invasions

Th-S4-01

Scaling up from local climate matching in gardens to continental naturalization success: the case of ornamental woody plants in Europe

Noëlie Maurel, Mark van Kleunen

University of Konstanz, Konstanz, Germany

The ornamental pathway supplies considerable numbers of alien plant species, of which many escape from cultivation and establish self-sustaining populations in the wild (i.e. they naturalize). The geography of cultivation (i.e. which species are grown where) may depend on species traits in the first place. In particular, the local pool of species cultivated in a given garden may be restricted to those that are climatically suited (hardy enough) locally. To which extent this is true, and whether this ultimately affects the chance for a species to naturalize in the larger region, has thus far been largely overlooked. To test this hypothesis, we took advantage of a large dataset of ~1500 ornamental woody plant species grown in ~200 gardens s.l. (botanic gardens, parks and arboreta) across Europe, where the status of reproduction has been reported for each species in each garden. We compiled these data with information about the native range of the species, their growth form and winter hardiness, as well as their year of introduction to Europe and planting frequency. We first assessed the drivers of local reproductive success (fruiting yes/no). We then tested whether local reproductive success could mediate the effects of species traits and introduction history on naturalization success in Europe. We found that local matching between species winter hardiness and garden climatic conditions was associated with a higher probability of fruiting. Furthermore, we found that naturalization success in Europe was positively associated with the proportion of European gardens where a species successfully reproduced. Together, our results suggest that local climate matching in gardens promotes local reproductive success, which in turn contributes to continental naturalization success.

Keywords: hardiness, traits, introduction history, reproductive success, establishment, indirect effects

Th-S4-02

Long-term dynamics of plant invasions: the role of residence time in determining invader performance

Christine Sheppard

University of Hohenheim, Stuttgart, Germany

Biological invasions are a major threat to biodiversity, but also pose useful natural experiments with the potential to provide many ecological and evolutionary insights. Aiming to explain causes of invasions, much research effort has focused on investigating differences between native and invaded ranges or between the two distinct groups of native and alien species. In contrast, temporal dynamics such as the potential effects of eco-evolutionary changes during the invasion process have received far less attention. However, new insights might be gained by comparing the dynamics of species and populations that differ in residence time and face different biotic and abiotic dissimilarities compared to their native range. This study investigated differences in invasion dynamics using Asteraceae species in Germany along an alien-native species continuum, which includes species of continuously increasing residence time (from recent neophyte over archaeophyte to native species). To investigate how residence time determines the performance and impacts of these plant species, a multi-species small-scale common garden experiment was combined with a large-scale macroecological analysis. In the experimental approach, small-scale establishment success in a native resident grassland community among 35 annual Asteraceae species with varying residence times was determined. From the macroecological perspective, a large-scale analysis of all Asteraceae species occurring in Germany illustrated how range sizes are influenced by residence time. At both scales, nonlinear patterns between plant performance and residence time were found, highlighting the importance of temporal dynamics. By contributing to a better understanding of the dynamic nature of biological invasions this study assists in explaining invasion mechanisms and determining appropriate management responses. Moreover, investigating temporal dynamics of invasions and associated changing biotic interactions among invaders and resident species will give insights to fundamental ecological and evolutionary processes in general.

Keywords: plant invasion, temporal dynamics, residence time, rapid evolution, biotic interaction, experiment, macroecology, alien-native continuum

Th-S4-03

Newspaper Stars in Feathers – reconstruction of passerine invasion history in New Zealand

Pavel Pipek^{1,2}, Petr Pyšek^{1,2,3}, Tim Blackburn⁴

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Bird introductions to New Zealand are a model system for macroecological analyses of invasiveness because the introductions of birds were deliberate, organized, and the Acclimatization Societies responsible for the majority of introductions kept good records. However, the propagule pressure data used for these analyses have recently been criticized, and indeed the data on which these studies are based have been subject to errors and misinterpretations. Recently, we published a case study of the history of Yellowhammer (*Aves: Emberiza citrinella*) introductions to New Zealand (Pipek et al. 2015) to show that such errors and misinterpretations can be corrected when all available documents (including newspaper articles) are utilized. In this paper, we extend the Yellowhammer case study to all passerine species imported to New Zealand, with the aim of producing robust and accurate data on the pathways and numbers of birds shipped to and liberated there in the second half of the 19th century. In total, we identified 129 records of ships carrying birds to New Zealand (mostly from Great Britain and Australia), from 35 of which we have information about shipping mortality (both the number of birds loaded and surviving). The data show that some species were liberated earlier than has generally been appreciated, even before the first Acclimatization Societies were founded. Some species were being translocated from one part of New Zealand to other (often in their hundreds), instead of being imported directly from Great Britain. Overall, therefore, these preliminary results show that the history of alien passerine introductions is more complex than thought based on works of previous researchers. How this affects our understanding of the drivers of establishment success in this system will be the subject of future analysis.

Keywords: birds, invasions, New Zealand, propagule pressure

Th-S4-04

Macroecological patterns of Europe's 100 of the worst invasive species under current and future conditions

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³*University Joseph Fourier, Laboratoire d'Ecologie Alpine (LECA), Grenoble, France*

⁴*Czech Academy of Sciences, Institute of Botany, Pruhonice, Czech Republic*

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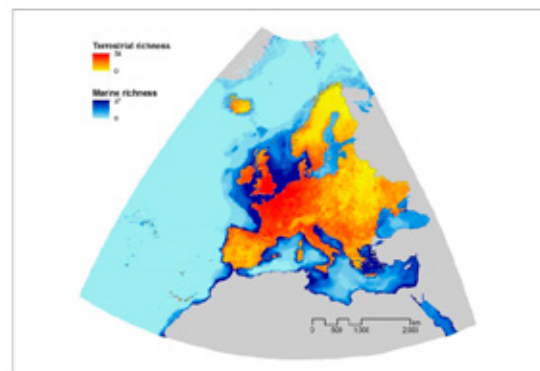
Among over 14,000 non-native species currently present in Europe, experts highlighted 100 species with some of the 'worst' ecological and socio-economic impacts. Here, we investigate macroecological patterns in their distribution under current and future climate conditions.

Species Distribution Models (SDM) were used to calculate Europe's suitability for each of the invasive species investigated. Beyond climate, we included information on global accessibility to account for the close relationship between invasive species distribution and human transportation. We projected SDM onto 12 different future scenarios combining different circulation models, emission trends and time periods. Sensitivity tests were conducted to investigate, and whenever possible correct, the influence on models of: algorithm, strategy of pseudo-absence selection, maximum number of presence records, spatial autocorrelation, sampling bias, and extrapolation onto novel climates.

The accuracy of SDM ranged from 0.87 to 0.99 AUC (0.61-0.97 TSS), which can be considered excellent. Between 47 and 73% of Europe's some of the worst invasive species are predicted to expand their range of distribution, depending on the future scenario analysed. Further, 41 species consistently showed range expansions for at least 10 out of the 12 future scenarios evaluated, whereas 32 species showed consistent contractions. Spatially, the Continental, Atlantic and Mediterranean (in that order) biogeographic regions accumulated the highest current and projected richness of invasive species. The core distribution of invaders shifted on average 37 ± 16 km per decade towards the north, and 17 ± 22 km towards the east of Europe. This velocity is two to six times faster than previously reported for native communities using a similar methodology. Range expansion was greatest at global mean temperature increases of 3.5°C , well above the 2°C cap recently adopted by the international community in Paris.

The effects of climate change are complex, multi-layered and context-dependent, which make estimation of future changes particularly difficult.

Yet, considering additional information on the species biological traits (movement ability, ecological generalization and reproductive strategy), dispersal capacity and niche conservatism, we conclude that invasive species are likely to track the predicted spatial changes in climate suitability. Our projections provide the best estimated trends of some of the worst invasive species in Europe's based on current knowledge.



Keywords: climate change, biological invasion, Paris Agreement, poleward shift, range expansion

Thursday, 15 September 2016 - 11:15 - 12:45

Session 5

Biogeography and macroecology of invasions

Topic continued from previous session

Th-S5-01

The drivers of the level of plant invasions world-wide

Franz Essl, Wayne Dawson, Holger Kreft, Petr Pyšek, Jan Pergl, Mark van Kleunen, Patrick Weigelt, Bernd Lenzner, Thomas Mang, Dietmar Moser, Stefan Dullinger, Marten Winter

University Vienna / Environment Agency Austria, Vienna, Austria

Biological invasions have become a defining feature of global environmental change. However, the factors that determine variation in the level of invasions world-wide are still poorly understood. Here, we present and analyze the level of plant invasions across invasion stages (i.e. the proportion of naturalized and invasive species relative to the native species numbers) in 849 regions world-wide.

We use the Global Naturalized Alien Flora (GloNAF) database, which has become the most comprehensive resource for alien plant species distributions (van Kleunen et al. 2015), as source for calculating naturalized and invasive plant species richness per region. We then analyze the level of invasions by naturalized and invasive plant species dependent on region variables by means of generalized linear mixed effects models. In this presentation, we will present key insights that have emerged from this analysis.

We show that highest absolute numbers of native plant species are found in tropical mainland regions, while naturalized species numbers peak in temperate to subtropical mainland regions. We find that highest numbers of invasive alien plant species are again reported for temperate to subtropical regions, but with a strong decline towards tropical regions. However, in relation to native species diversity the global level of plant invasions shows a remarkably different picture. Highest levels of naturalized plant species are found in tropical and subtropical islands across the globe, with 82 of all islands (26%) having accumulated more naturalized alien plant species than are native on the same island. This contrast in the level of invasion between islands and mainland regions is perpetuated for invasive alien species. Finally, we reveal how environmental and anthropogenic pressures and biogeographic context interact in driving the level of plant invasions, and how the relevance of these pressures changes across invasion stages.

Reference

van Kleunen M. et al. (2015). Global exchange and accumulation of non-native plants. *Nature* 525: 100–103.

Keywords: alien species, biogeography, distribution, macro-ecology

Th-S5-02

Patterns and predictions of the global spread of alien species: The intermediate distance hypothesis

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The global distribution of alien species is largely driven by human activities such as global trade, horticulture or tourism. For example, the number of alien species of a country has been shown to be highly related to the volume of imported commodities. However, the global spreading dynamics of alien species, e.g. the spread between continents, remain poorly understood although knowledge about their spread is crucial to understand the global distribution of alien species. Furthermore, although many studies analyzed the relationship between alien species numbers and imported commodities, the global flows of alien species have never been compared to the global flows of commodities. We will present a first analysis of the geographic distance between native and alien regions of alien species using distributional data of 1380 species from various taxonomic groups. We show that the number of alien species is roughly spoken a hump-shaped function of geographic distance between native and alien ranges with highest species numbers at intermediate global distances of around 10,000 km. In contrast, the volume of exchanged commodities is highest at short distances. Consequently, exchanged trade volume alone is a poor predictor of alien species spread. We solve this discrepancy to common expectations by formulating a simple model combining exchanged trade volume with a measure biogeographical dissimilarity of ecological communities. Despite its simplicity, the model can already explain a large amount of the observed variability. Formulated in the intermediate distance hypothesis, we state that trade volume is only a good predictor in conjunction with the consideration of the proportion of alien to native species at a given distance. The process of invasion is often very complex for single species, but here we show that the resulting global spreading patterns across taxa can already be explained by simple models.

Keywords: global spread, model, trade

Th-S5-03

Plant invasions in mountains: improving invasive species distribution models' performances by accounting for the road network

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Roads are known to act as corridors for the dispersal of non-native plant species into mountain ecosystems. Previous research has shown a strong correlation between mountain roads and the distribution of most non-native mountain invaders, with upward expanding ranges of non-native species in roadsides compared to their distribution in the surrounding vegetation. With their different microclimate, reoccurring disturbance events, altered biotic interactions and facilitation of species movement, roads show several characteristics that indeed improve the chances for range expansion of non-native species. We argue that the connection of most common global non-native species with the road network in mountains could be more determinant of their spatial distribution than their climatic niche, as most of them are climate generalists and able to cope with a wide range of climatic conditions. It is thus key to integrate roads into species distribution models (SDMs) of non-native plants in mountains, as it will greatly improve our ability to describe and predict the current and future distribution of mountain invaders. With an elegant dataset of the occurrence of non-native species along mountain roads in more than ten mountain regions all over the world (from MIREN, the Mountain Invasion Research Network: <http://www.mountaininvasions.org>), we show here how SDMs based on a combination of fine-grain (50 m x 50 m) climate and topographical data and accounting for "distance to the road" as an extra predictor variable greatly improves model performances. We highlight the important implications for the conservation of mountain environments in a warming climate.

Keywords: Disturbance, mountains, plant invasion, roads, SDMs

Session 5

Invasive species and changes in landuse

Th-S5-04

Influential factors across an invasion process: the invasion of the Scotch broom in Nahuel Huapi National Park (Argentina)

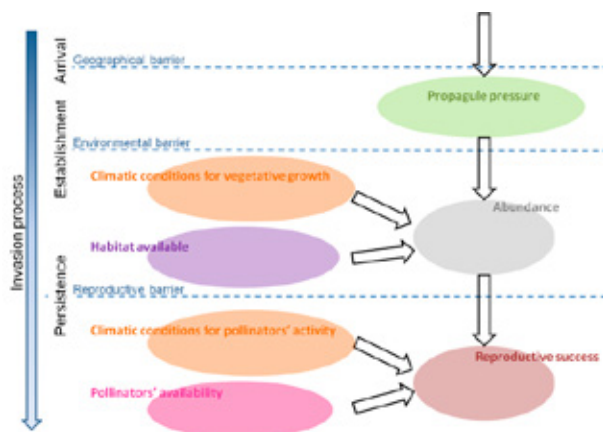
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Exotic species have to overcome a series of biotic and abiotic barriers in order to succeed and become invasive. Influential factors, either intrinsic of the exotic species or environmental, change their relative importance along the invasion process. For instance, factors determining the arrival of an exotic entomophilous plant to a new area might highly differ from those determining the availability of suitable pollinators, decisive for its reproduction and persistence.



In this study, we built a theoretical causal model for the invasion process of entomophilous exotic plants (Figure).

Our objective was to complete this model with the most explicative factors, testing it through Structural Equation Models. For that purpose, we studied the invasion of the Scotch broom (*Cytisus scoparius*) in Nahuel Huapi National Park (Argentina); a very interesting study system for several reasons. First, *C. scoparius* exclusively depends on sexual

reproduction and is self-incompatible and alogamous. Besides, once its flowers are visited, they remain tripped, being the proportion of tripped flowers a good surrogate of visitation rate, allowing the estimation of visitation rate in a high number of populations without the need of conducting pollination censuses. Second, the study area is an ecotone between the steppe and the humid forest, allowing the exploration of wide environmental (climatic, topographic and land use) ranges. Along three transects with marked and non-correlated environmental gradients, we studied 107 populations of *C. scoparius*, in which we estimated its cover in 100m radius, as a proxy of its establishment; and visitation rate, as a proxy of its reproductive success. In addition, in each population we measured a total of 11 climatic, topographical and land use factors.

The propagule pressure was determined by urban cover at 100m radius, as this plant is used in gardens as ornamental. This pressure, together with the annual mean temperature, positively affected *C. scoparius* cover. Interestingly, the relationship between *C. scoparius* cover and visitation rate was negative. Finally, the availability of pollinators was determined by both urban and shrubland covers at 500m radius. Shrubland cover might provide suitable areas for pollinators. However, urban cover had a negative effect on the availability of pollinators and subsequent visitation rate, probably because there other ornamental species are simultaneously in bloom competing for pollinators with *C. scoparius*. We expect this approach to be a useful theoretical framework for other invaded systems.

Keywords: *Cytisus scoparius*, entomophilous alien plants, landscape scale

Th-S4-05

Patterns of plant invasions over 60 years in a developing forest

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For many years, intact forests have been thought to resist invasion. However, recent evidence suggests that even undisturbed forests are susceptible to invasive plant species. This could either be because species are able to invade following disturbances and then persist (the window of opportunity pattern) or because they are shade tolerant and able to spread even in undisturbed conditions. Using a long term dataset, I examined the overall patterns in abundance and diversity of exotic and invasive species over time to determine the effects of forest development and maturation on invasion. I then explored environmental factors influencing the spread of six common invasive species at the study site. Data were collected in 890 3X3m plots every 10 years beginning in 1952 in a natural area in southeastern Connecticut, USA. In 1952 the study area consisted of a mix of old fields, shrub land and secondary forest, but forests have been allowed to develop and mature since then throughout the site.

Overall, the abundance of exotic species declined significantly in the first 20 years of forest development. However invasive exotic species increased across the 60 years, due largely to six species. Three of these increased dramatically over the first 30 years but have since leveled off – suggesting the window of opportunity pattern - while the other three invaded later and continued to increase. Across the study site, the youngest forests have been more heavily invaded, but this pattern has decreased over time with some of the species (particularly *Celastrus orbiculatus*) progressively moving into older forests. Tree basal area was not a strong predictor of invasions for any of the species, suggesting that they are not taking advantage of canopy gaps to spread. Invasion by these species was greater in areas with higher existing richness and closer to existing populations of the species. These results suggest that while undisturbed forests are likely to have fewer exotic species overall, forests will continue to be invaded by a subset of species, either taking advantage of windows of opportunity or through the spread of shade tolerant invasive species. Both patterns can operate simultaneously.

Keywords: temperate forest, shade-tolerance

Thursday, 15 September 2016 - 14:00 - 14:45

Keynote 3 - Non-native pests and pathogens

Th-K-03

Invasive Alien Species and Pathogens: interactions, impact and strategies for control

Alison Dunn

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Species distributions are changing at an ever-increasing rate as a result of human activity. Two key processes of redistribution - biological invasion and disease emergence - are often interlinked. Indeed, for nearly one quarter of the invasive alien species (IAS) in “100 of the world’s worst” list, environmental impacts are linked to diseases of wildlife. Parasites (macroparasites, microparasites) are frequently implicated in altering the outcome or impact of invasions. Parasites may be left behind in the host’s ancestral range, affording the host “enemy release”, or they may be introduced into new communities along with invading species. I will use studies of freshwater ecosystems to illustrate how parasites can change the strength of interactions between invasive and native species.

Although IAS are a significant source of ‘pathogen pollution’ defined as the human-mediated introduction (often unintentional) of a pathogen to a new host or region, surprising little is known about the biology of alien pathogens and their biodiversity impacts after introduction into new regions. I discuss the outcome of a recent EU workshop which identified areas for research and action, including those relevant to the processes of introduction and establishment of an alien pathogen and to prediction of the spread and associated impact of an alien pathogen on native biota and ecosystems.

In contrast with international policy on emerging diseases of humans and managed species, global policy on invasive species and parasites of wildlife is fragmented and the lack of international cooperation encourages individual parties to minimise their input into control. I look at the parallels between the process of biological invasion and of disease emergence, and discuss how these threats can be countered, focusing on biosecurity.

Keywords: biological invasions, pathogens

Thursday, 15 September 2016 - 14:45 - 16:00

Session 6

Non-native pests and pathogens

Th-S6-01

Alien species of human health concern: Evidence syntheses for impacts and management effectiveness

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Alien species are more and more recognized for having impacts detrimental to human health through injury, allergy, or as vectors of disease. Increasing international trade and climate change are likely to impact on spread, abundance, physiology or phenology of alien species, potentially altering their health impacts. Yet despite this topic receiving increasing attention in the scientific literature, there have been few attempts to quantify recent changes in human health impacts. We conduct different approaches of knowledge and evidence syntheses on this topic for Europe: First, we present findings from a systematic map of the literature identifying evidence of any change in the occurrence, frequency or severity of impacts of alien species on human health. Relevant studies related to only a few species, often report specific cases and rarely link health impacts with ecology, distribution or spread. Much of the available evidence represented first reports of illness or injury resulting from exposure to alien species. Five studies provide the first reports of autochthonous transmission of exotic diseases (two of Chikungunya virus and three of Dengue fever) by non-native mosquito species of the *Aedes* genus (*A. albopictus* and *A. aegypti*) established within Europe with up to more than 2000 humans affected. Evidence also suggests that harmful blooms of alien unicellular algae such as *Ostreopsis* species are causing significant health impacts along Mediterranean coasts. Other impacts arising from contact with alien animal species include dermatitis associated e.g. with contact with the oak processionary moth *Thaumetopoeia processionea*. Beside first reports of impacts, changes in sensitisation levels, e.g. to *Ambrosia artemisiifolia*, among the human population are reported. These studies indicate that levels of sensitisation are rising and the proportion of young people sensitised is increasing. Secondly, we conducted a systematic review to assess the effectiveness of management options used for common ragweed *Ambrosia artemisiifolia* and the effect of confounding factors such as habitat, climate and frequency and timing of the treatments. And thirdly, we developed a questionnaire on alien species and health impacts developed for Austrian stakeholders in environmental and health management to ask respondees about priority taxa, importance of expected direct health impacts (such as infections, allergies), and measures (environmental prevention, environmental control, medical prevention, medical therapy, etc.) to be recommended.

Keywords: health impacts, management effectiveness, evidence synthesis, knowledge synthesis, systematic map, systematic review, questionnaire

Th-S6-02

Exploring the barriers to predicting alien pathogen invasions

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Over the last few decades there have been major advances in our understanding of biological invasions but very little is known about the biology of alien pathogens (defined as a disease-causing micro-parasite (an agent living in or on a host) that includes viruses, bacteria, fungi and fungus-like organisms) and their biodiversity impacts. Environmental impacts are linked to diseases of wildlife for one quarter of invasive alien species (IAS) listed as the “100 of the world’s worst”, but research and policy focus mainly has been on diseases of humans, vertebrate livestock and cultivated plant species. The spread of alien pathogens which affect wildlife has received considerably less attention.

Species inventories are recognised as critical for the management of biological invasions, informing horizon scanning and surveillance, and underpinning prevention, control and elimination of IAS. There have been major developments in the availability of high quality data on IAS which can be used to inform science, policy and ultimately conservation. However, very few include any alien pathogens and those that do so include only a few, notably, and not surprisingly, those with devastating effects on biodiversity such as *Aphanomyces astaci*, the causal agent of crayfish plague, and *Batrachochytrium dendrobatidis* and *B. salamandrivorans*, the chytrid fungi of amphibians. The threats posed by alien pathogens to endangered species, ecosystems, and ecosystem services should receive greater attention internationally through legislation, policy and management, both globally and locally. We explored the barriers to understanding alien pathogens, using expert consensus approaches through a workshop of the COST Action ALIEN Challenge, and identified key areas for research and action. Here I will describe the key findings and highlight the need for consideration of alien pathogens within an interdisciplinary approach to the health of people, domestic animals and wildlife.

Keywords: Invasive alien species, wildlife disease, legislation, One Health Initiatives, Microparasites

Session 6

Socioeconomic impacts of biological invasions

Th-S6-05

Plant pest impacts: A common set of metrics

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¹¹*Department of Agriculture and Water Resources, Canberra, Australia*

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Agricultural stakeholders are in need of a common set of metrics to evaluate plant pests. While conceptual frameworks for defining and classifying pest impacts have been developed in the invasion biology literature, many of these are limited by a lack of criteria for socio-economic and trade impact outcomes, which are largely prevalent in plant production systems. Despite considerable efforts to define crop loss assessment, yield losses, economic injury levels and damage thresholds for plant production systems, a generalised methodology for classifying such losses and impacts has never been clearly articulated. A generalised and common framework for quantifying and comparing pest impacts would be an invaluable tool for all plant biosecurity stakeholders. Such a framework would allow transparency, flexibility (in development and application) and harmonisation of pest management and prioritisation across spatial scales and jurisdictions. We present here a plant pest impact classification system that articulates, defines and classifies the impacts of pest species (both alien and native; historical, current and potential) in plant production systems. Criteria were defined by magnitude of impact, with a focus on production specific metrics. Economic assessment parameters used to analyse plant biosecurity impacts, risk assessment guidance tools developed by the IPPC, discussions with pest risk assessment professionals and the structure and insight of recent environmental impact classification schemes were used to identify criteria. Twenty impact metric criteria were identified, assigned to four key metric types: economic, management, spatiotemporal and socio-political, and nested under key components of the invasion and impact process. Host crop value, market access, feasibility of management and reversibility are identified as disruptor metrics, likely to influence overall impact classification by at least an order of magnitude difference compared to other criteria. Measures of spatial distribution, yield and quality losses and management response were also identified. Utility of the metric system is explored through application to Australian and New Zealand plant pests. This system demonstrates the value of integrating plant protection science with invasion biology, to derive a comprehensive measure of pest impact in agroecosystems. We acknowledge the support of the Australian Government's Cooperative Research Centres Program. This work forms a part of the Plant Biosecurity CRC project 1109: Pathways and Risk Assessment Framework for High Impact Species.

Keywords: alien invasive species (AIS), biosecurity, consequences, crop loss assessment, exotic species, non-indigenous species (NIS), plant production, prioritisation, pest effects, quarantine

Session 6

Restoration of invaded ecosystems

Th-S6-03

Restoration of a blackberry-invaded unique forest in Galápagos: impacts on the vegetation, birds and invertebrates

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Understanding the interactions of introduced species with their novel environment is important for any ecological system. But where invasive species pose a threat to endangered species, it is especially important since it provides a holistic perspective of invader – ecosystem interactions. Blackberry (*Rubus niveus*) and other introduced species have invaded a unique forest on the Galapagos island of Santa Cruz dominated by the endemic tree *Scalesia pedunculata*, which is a critical habitat for Darwin's finches. High cover of invasive *Rubus* has led to significantly lower native plant species richness and cover, as well as to changes in the *Scalesia* forest structure. The intense use of herbicides by the Galapagos National Park Directorate to control these invasive species may have led to direct and indirect changes in plant communities and the composition of invertebrate communities, which could negatively impact insectivorous birds.

Consequently, we initiated a community level study to determine the direct and indirect effects that the control of *Rubus* and other invasive species has on the plant, invertebrate and bird communities. This involved quantifying plant and invertebrate diversity and abundance in 34 plots (10×10 m) and the effects of habitat change on food availability. We also studied impacts on the breeding success (nests that produced at least one fledgling) of Darwin's finches.

Our data suggest that the control of invasive plant species led to lower invertebrate abundance as herbicide usage results in the temporary removal of the entire understory. Whether this resulted in a lower breeding success of the finches is not clear at this moment, since due to drought conditions in 2015, the overall breeding success was low. We expect clearer results from the current breeding season. After an initial drop in the density and cover of plant species after herbicide application, a dramatic recovery of native plant species and especially of *Scalesia pedunculata* ensued. Although there were no *Scalesia* seedlings in the heavily *Rubus*-invaded plots, over 300 seedlings occurred in some of them only 5 months after the last herbicide application. In addition, the natural regeneration of *Scalesia* and other native and endemic species equalled that of those planted after cultivation in the nursery, making cost- and labour-intensive restoration efforts unnecessary. These results suggest long term benefits of the restoration efforts of the *Scalesia* forest on Santa Cruz Island carried out by the Galapagos National Park Directorate.

Keywords: *Rubus niveus*, ecological restoration, invasive species control impacts, Darwin's finches

Th-S6-04

Challenges to invasive alien plant control and ecosystem restoration in the Cape fynbos, South Africa

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Invasive alien plants are of widespread concern due to their severe impacts on the conservation of South Africa's fynbos biome. Although a large amount of money is being spent on invasive alien plant control in fynbos, there are concerns that current approaches are failing to reduce the problem. To find effective solutions, it is necessary to accurately estimate the extent of the problem and the effectiveness of current control operations. We investigated this issue at two scales. First, we assessed the extent of invasion in fynbos protected areas, which experience ongoing invasion by alien woody plants in the genera *Pinus*, *Hakea* and *Acacia*. We estimated the resources and measures that would be required for their effective control. At a smaller scale, we examined a long-term invasive alien plant clearing effort over the last thirteen years in a mountain catchment within the fynbos biome. Our objectives were to assess the effectiveness of control measures in this catchment over 13 years (2001-2014) and the degree of native vegetation recovery. The catchment was historically planted with pines (by the 1940s), primarily *P. pinaster* and *P. radiata*, two of the most invasive *Pinus* species in fynbos. Clearing efforts were initiated in 2001 and have continued to the present. We compared vegetation composition and cover between cleared areas that were previously plantations or invaded natural vegetation, with a reference site (uninvaded fynbos). We evaluated the results in light of patterns of landscape-scale resource allocation and invasive alien plant cover. We suggest that current approaches to invasive alien plant control in fynbos should be rigorously re-evaluated with respect to specific restoration objectives. Strategic management and allocation of resources will be necessary to effectively achieve desired future conditions.

Keywords: biodiversity, Cape Floristic Region, conservation, invasion, management

Friday, 16 September 2016 - 09:00 - 09:45

Keynote 4 - Genetics and evolution of invasive species

Fr-K-04

Evolution of Osmoregulation Arising from Fluctuating Seas, and Implications for Invasions

Carol E. Lee

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An intriguing question remains as to why some groups show the evolutionary capacity to invade novel habitats, whereas most do not. In recent years, many species invading freshwater habitats have originated from more saline environments, disproportionate to their rate of transport. Identifying the specific genetic mechanisms that underlie physiological evolution during freshwater invasions might bring us closer to determining why particular populations have the capacity to cross this formidable boundary, and also provide general insights into why certain species have the ability to invade. The copepod *Eurytemora affinis* has invaded freshwater habitats multiple times independently from saline sources within the past century. Interestingly, some populations of *E. affinis* have the capacity to invade, whereas others do not. What properties characterize the invasive populations?

To dissect evolutionary responses during these independent habitat invasions, we integrated analyses of physiological function with comparative genomics. We analysed evolutionary shifts during invasions for pairs of ancestral saline source and derived freshwater populations across multiple independent invasions from genetically distinct clades. We found evolutionary shifts in function (ion uptake), as well as in expression of genes spanning many functional categories, including osmoregulation, energy production, and stress response. In many cases, there were striking parallel evolutionary shifts across independent invasions, particularly with respect to ion uptake activity and expression. The evolutionary parallelism we observed in this study might have relevance for taxonomically different but ecologically similar species that invade across similar habitat clines.

Physiological evolution during invasions appears to occur through natural selection acting on standing genetic variation in the native range. Balancing selection in the native range would be important for maintaining this genetic variation, enabling a population to become invasive. Consistent with this fact is the striking pattern that invasive populations appear to originate from habitats characterized by fluctuating conditions, which could lead to a form of balancing selection. In addition, we found experimentally that the copepod *E. affinis* exhibits reversal of dominance in salinity tolerance between saline and freshwater habitats (or marginal overdominance). The combination of fluctuating selection and marginal overdominance would greatly promote the maintenance of genetic variation in the native range, providing genetic substrate upon which selection could act during invasions. The tendency for fluctuating habitats to increase the evolutionary potential of populations might explain why so many invaders arise from the fluctuating habitats of the Ponto-Caspian Seas.

Keywords: ionic regulation, balancing selection, standing genetic variation, adaptation, physiology, genomics, Ponto-Caspian

Friday, 16 September 2016 - 09:45 - 10:30

Session 7 - Genetics and evolution of invasive species

Fr-S7-01

Using genetic tools to inference expansion pattern of the raccoon dog

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The extent of gene flow during the range expansion of non-native species influences the amount of genetic diversity retained in expanding populations. We analyse the population genetic structure of the raccoon dog (*Nyctereutes procyonoides*) in north-eastern and central Europe. This invasive species is of management concern because it is highly susceptible to fox rabies and an important secondary host of the virus. We hypothesized that the large number of introduced animals and the species' dispersal capabilities led to high population connectivity and maintenance of genetic diversity throughout the invaded range.

We genotyped 332 tissue samples from seven European countries using 16 microsatellite loci. Different algorithms identified three genetic clusters corresponding to Finland, Denmark and a large 'central' population that reached from introduction areas in western Russia to northern Germany. Cluster assignments provided evidence of long-distance dispersal. The results of an Approximate Bayesian Computation analysis supported a scenario of equal effective population sizes among different pre-defined populations in the large central cluster.

Our results are in line with strong gene flow and secondary admixture between neighbouring demes leading to reduced genetic structuring, probably a result of its fairly rapid population expansion after introduction. The results presented here are remarkable in the sense that we identified a homogenous genetic cluster inhabiting an area stretching over more than 1500km. They are also relevant for disease management, as in the event of a significant rabies outbreak, there is a great risk of a rapid virus spread among raccoon dog populations.

Keywords: carnivore, genetic diversity, invasion genetics, invasive species, long-distance dispersal, population genetics

Fr-S7-02

Using population genetics to understand the evolutionary potential of an introduced parasitic nematode, the raccoon roundworm (*Baylisascaris procyonis*)

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The raccoon roundworm (*Baylisascaris procyonis*) is a common gastrointestinal parasite of the raccoon (*Procyon lotor*), that is emerging as an important helminthic zoonosis. Translocations of raccoons have increased the global geographic range its roundworm as well. Raccoons are particularly abundant and wide-spread in Germany, where they can occur at high densities. Recent genetic work on the raccoon has provided evidence for at least four independent introduction events, which gave rise to genetically differentiated subpopulations in incipient contact of relatively high genetic diversity. The roundworm, however, does not occur in all raccoon populations and might therefore be much less genetically diverse due to reduced propagule pressure. In the present study, we aimed to establish how frequently the parasite was introduced into Western Europe and to examine the changes in genetic diversity during the invasion process. We collected *B. procyonis* from a total of 258 raccoons sampled in central Germany (Lower Saxony, Saxony Anhalt, Hesse). In our study sites, two raccoon founding populations, that both are subjected to *B. procyonis* infection, are in contact. We sequenced nuclear and mitochondrial markers, based on the mitochondrial genes cytochrome c oxidase 1 and 2 (CO1 and CO2) and the ribosomal ITS1, ITS2, 5.8S and 28S genes. We performed genotyping using 19 microsatellite markers. Our results provide evidence for a strongly reduced genetic diversity of the parasites introduced range. We will present and discuss our results relating to the number of independent introduction events.

Keywords: Raccoon roundworm, *Baylisascaris procyonis*, Raccoon, *Procyon lotor*, parasite, invasive species

Fr-S7-03

Exploring the invasion history of an exotic pest based on genetic markers: the case of the Asian long-horned beetle (*Anoplophora glabripennis*).

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Insects are one of the most numerous groups of alien organisms introduced in Europe and as a result of globalization, the number of human-mediated introductions keeps growing. Among all the continents, Asia is so far considered as the region from which most of the newly-arrived alien species originate.

The Asian long-horned beetle (ALB) *Anoplophora glabripennis* is one of the insect species which benefited from international freight from Asia to Europe. It has been first detected in North America in 1996, then in Europe in 2003. This highly polyphagous species is able to infest a wide range of deciduous trees, especially in urban areas where its management results in significant economic costs.

In a context of recent European outbreaks (France 2013, Switzerland and Finland 2015), and in order to anticipate and to manage further ALB introductions, it is particularly important to uncover population's invasion routes as well as their pathways of dispersal in the invaded areas.

This work aims at evaluating the genetic structure of invasive populations in order to assess if the European outbreaks resulted from multiple independent introduction events or from the dispersal of a primary introduced population. We used sequences of mitochondrial COI gene as a preliminary approach. Our dataset covered most of the Europeans outbreaks, some populations in North America and some in the native Asian range.

So far, the analysis of 36 populations from China and Korea revealed 23 haplotypes, with a very blurred geographic structure, probably resulting of an historic arrangement faded by potentially more recent population translocations, as hypothesized in previous studies. Only ten haplotypes were yet observed in Europe, three of them being shared with Asia and North America, five being private haplotypes and two being shared with Asia only. The genetic structure observed in Europe suggests a complex invasion scenario which likely includes several introduction events as well as dispersal within the invaded areas.

Keywords: invasive species, genetic structure, Asian Longhorned Beetle, *Anoplophora*, mitochondrial markers, insect

Friday, 16 September 2016 - 11:15 - 12:45

Session 8

Genetics and evolution of invasive species

Topic continued from previous session

Fr-S8-01

Out of the Black Sea: Phylogeography of the invasive killer shrimp

***Dikerogammarus villosus* across Europe**

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The killer shrimp, *Dikerogammarus villosus* (Crustacea Amphipoda), has been recognised as one of the 100 worst alien species in Europe, representing a major issue for local biodiversity and ecosystem functioning. During the last 20 years, it has colonized Central and Western Europe via the central and southern invasion corridors. Its spread was associated mainly with commercial shipping in large waterways but it was also transported overland to several Alpine Lakes and even overseas to the British Isles. This studies is an attempt to track the routes and dynamics of invasion of this one of the most effective freshwater invader. Molecular methods were used to reveal phylogeography of *D. villosus* in the native and invaded area as well as to tackle conservation issues. Through molecular studies we aimed to understand the dynamics of the species invasion in Europe. Our material consisted of 606 individuals sequenced for 16S and COI mitochondrial markers and 1228 individuals sequenced for seven microsatellite loci each from its entire European range including native and colonized area. In a result, four major populations in Danube, Dnieper, Dniester mouth and also Durngol Liman in Turkey were identified in the species native area. Two of them, from Dnieper and Danube mouth, were donors for independent routes of invasion along central and southern corridor. Microsatellite data allow to indicate Western Europe populations as a origin of latest introduction of *Dikerogammarus villosus* to UK and Alpine Lakes. Strong bottleneck effects may be seen in the populations from the isolated Alpine Lakes, showing that they come from a very low number of introduced individuals (showing high risk of overland transport). Such complex knowledge on the phylogeography of the killer shrimp may help to decrease risk of its future introductions to other areas, such as the North American Great Lakes and Balkan lakes.

Keywords: invasive species, dispersal, overland transport, demography, Ponto-Caspian, routes

Fr-S8-02

Never underestimate your opponent: adaptive phenotypic response in a recent invader

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Invasive species frequently need to cope with ecological conditions that are dissimilar from those they adapted to, presenting an opportunity to investigate how phenotype changes across short time scales as a consequence of altered genotype-environment interaction. Furthermore, phenotypic comparison between native and invaded ranges not only addresses basic eco-evolutionary questions but also determines management actions helping e.g. to estimate species invasion potential. The guttural toad *Sclerophrys gutturalis* is a generalist and synanthropic species naturally distributed in tropical and subtropical central and southern Africa. It has recently invaded a peri-urban area of Cape Town (CT) and despite a sustained extirpation program the invasive range is still in expansion. The ability of the species to thrive and spread across CT is surprising since the area is characterized by a Mediterranean climate that is consistently drier and colder than that of the native range. Moreover, the introduction is very recent, with the species first being detected in 2001. We measured the field hydration state of guttural toads from the CT invasive population and a potential founder population from Durban. We also obtained from laboratory trials: i) rates of evaporative water loss (EWL) and water uptake (WU), ii) sensitivity of locomotor performance to hydration state, iii) critical thermal minima (CTmins) and iv) interaction between CTmin and hydration state. In the field, hydration levels of CT toads were significantly lower than in Durban toads. Although our lab experiments showed that the two populations did not significantly differ in their rates of EWL and WU, the effect of hydration state on locomotor performance varied substantially, with CT individuals outperforming Durban individuals when dehydrated but not when fully hydrated. Also CTmin was significantly lower in CT individuals than in Durban individuals. This difference remained unaltered despite the hydration state of the toads. Thus, we found that the invasive population shows in less than 20 years from the introduction an adaptive phenotypic response that may be due to genetic adaptation or phenotypic plasticity. Our results have management and conservation implications because they show that the invasion potential of this species in CT is already higher than we could infer from its native range.

Keywords: amphibian, anuran, biological invasion, physiology, hydration level, locomotion, evaporative water loss, water uptake, critical thermal minimum

Fr-S8-03

A multidisciplinary insight in *Robinia pseudoacacia* genetic and phenotypic diversity

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Robinia pseudoacacia is one of the 100 worst invasive species in Europe. In order to evaluate the mechanisms behind its invasiveness, we analysed the plasticity and genetic diversity of its populations, in a multidisciplinary approach. Molecular markers were developed to investigate the genetic structure and differentiation among populations. Comparative common gardens were set up to test for genetic differentiation and plasticity of phenotypic traits across the invaded range.

SNPs markers were developed from de novo RAD-seq assembly. Among 2020 RAD-loci, more than one third was identified as potential paralogous, and was filtered accordingly and 336 SNP were validated by genotyping as suitable markers. Populations from the USA (13), Belgium (10), Hungary (3) and Romania (2) were genotyped. Clones were detected with a maximum of 197m between two clones, indicating a high capacity of vegetative reproduction. A clear structure was observed between the native range and Europe. However, no structure was observed within Europe, suggesting an important and long-term gene flow between populations.

In parallel, 2000 seeds from 10 populations in Southern France and 10 populations in Belgium were sampled to set up a controlled experiment: seedlings were cultivated in two climatic chambers set at 18°C and 22°C, respectively (representative of Belgium and France spring temperatures). Germination and phenology of young seedlings were monitored, along with growth and photosynthetic traits. One individual per family was genotyped using SNP markers. Populations demonstrated a strong plasticity to temperature for all measured traits, the warmer environment being generally more suitable whatever the origin of the population. No genetic differentiation was evidenced using phenotypic traits and QST indexes; but the QST - FST comparison underlined a slight genetic differentiation at the molecular level. Overall, the genetic structure of these introduced populations demonstrated no local adaptation, but a high level of admixture with presence of some outlying populations.

The genetic differentiation between French and Belgian populations was not structured by range, and rather indicated the existence of particularities in some of the sampled populations. Results of the phylogeographic study in Belgium indicates a large genetic diversity and differentiation from native populations. Thus questions remain on the origin of the European populations, and the relative role of admixture, evolutionary processes and tree breeding in *R. pseudoacacia* introduction and invasion history.

Keywords: population diversity, temperature plasticity, molecular marker, invasive tree

Session 8

Engaging the public with the topic on invasive species

Fr-S8-04

Public and expert perception of invasive neobiota and development of neobiota communication tools

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A crucial prerequisite for a successful prevention and management of invasive alien species (IAS) is the communication of the problems and threats of IAS in target groups as well as in the general public. To prevent new introductions and establishments, as well as a further spreading of IAS, the knowledge of the topic and of the respective species are of utmost importance. In addition, public critique can hinder measures to combat IAS, as some species might also provide aesthetic or economic benefits. To examine the awareness and knowledge of IAS, and preferences for six invasive neophytes and their management options in Switzerland, a representative Swiss-wide public survey was conducted. Complementary, the survey was conducted among Swiss neobiota experts to compare public and expert attitudes. In a next step, workshops were conducted by the responsible authority for neobiota of the Canton of Zurich to identify problems and gaps of the neobiota communication.

The public survey revealed that there is a rather weak knowledge of the topic as well as the problems related to IAS, whereas the species themselves are almost unknown. However, interventions to combat invasive neophytes are supported. Compared to the public, experts show a higher knowledge of the topic and the species and, to some extent, different management priorities. The workshops at the cantonal authority revealed a missing consensus among the different departments dealing with invasive neobiota. A consequence is an inconsistent communication to external stakeholders, which leads to misunderstandings and discrepancies. Further, the workshop revealed a lack of public discussion on the threats and damages related to IAS. To build a consensus in neobiota communication, about a dozen neobiota key messages were identified and formulated as communication guidelines in a participative process with all relevant departments.

Our findings provide useful insights for designing information campaigns and communication concepts to increase the knowledge of threats and problems of IAS in relevant target groups as well as in the general public. Thus, they can be helpful to develop successful IAS intervention and prevention strategies for a sustainable management of invasive neobiota considering both ecological and social factors. Further, it might be interesting to evaluate the effectiveness of the neobiota key messages after introducing them in communication tools.

Keywords: invasive neophytes, public survey, expert survey, communication concept, knowledge, acceptance, preferences, key messages, consistent communication

Fr-S8-05

Smartphones: changing the way invasive species are reported

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Smartphones have provided professionals with a tool for mapping invasive species that is as accessible to experts as to citizen scientists. Operational through the University of California Los Angeles (UCLA) from 2008-2011, the What's Invasive application proved that reporting invasive species occurrences via a smartphone application was a viable option. University of Georgia – Center for Invasive Species and Ecosystem Health (Bugwood) was asked to take over What's Invasive in 2011 after the initial project period at UCLA expired. Bugwood worked with partners in the state of Florida and together they developed the smartphone application, IveGot1 (<http://apps.bugwood.org/apps/ivegot1/>), to report invasive species occurrence and data housed and available through EDDMapS. Soon, other invasive species monitoring and management programs became interested working with Bugwood to develop tools. Users wishing to report invasive species in the western U.S. can do so through the EDDMapS West smartphone application or website. In 2012, when EDDMapS West was launched, reports came in equally from the website and application. As of 2015, the EDDMapS West application accounts for 89.53% of user contributed reports and 10.47% from the website. System-wide in 2015, 69.94% of reports from individuals are coming from a smartphone application (<http://apps.bugwood.org/>) and 35.06% are coming from the EDDMapS website. The most important factors in ensuring a successful application are a well-designed and easy to use application, marketing and publicizing of the project, and maintaining communication with the project partners and the reporters.

Keywords: smartphone application, data aggregation, citizen science, early detection, monitoring, management tools

Fr-S8-06

Engaging stakeholders on the management of invasive species: a step by step framework

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Invasive species have major ecological and socioeconomic impacts in their novel ranges and many invaders have both benefits and costs. This often raises substantial conflicts between interest groups. As a result, there is increasing interest in assessing the perceptions of different stakeholders positively and negatively affected by invasive species. However, in most cases, there is still very limited collaboration between stakeholders – scientific researchers, the commercial sector, invasive species managers, policy makers, non-governmental organisations and the public. This often results in the failure to develop and implement sustainable management strategies for invasive species.

To better understand the need, barriers and options to engage stakeholders in invasive species management, a two-day workshop was organized in Cape Town (South Africa), with 20 participants working with biological invasions in different organizations. This included academics and managers working on a variety of organisms and in different areas (urban vs. rural) and ecosystems (terrestrial and aquatic). During the workshop, a stakeholder engagement framework for management of invasive species was built, as well as a detailed analysis of each of its steps. After the workshop, the framework was further discussed through additional meetings and e-mail communication including participants from Australia, Réunion and the United Kingdom. Finally, each step of the framework was further augmented by searching the scientific and grey literature.

The proposed engagement framework consists of 15 steps: (1) identify and categorize stakeholders, (2) identify the benefits and costs of the species or group of species, (3) explore influential stakeholders' perceptions, (4) identify key stakeholders for engagement, (5) develop an aim for the management action and state the rationale for engagement, (6) engage key stakeholders, (7) re-explore selected stakeholders' perceptions, (8) revise the aim for a management action, (9) develop management objectives and time frames with selected stakeholders, (10) design a management strategy, (11) empower stakeholders' ownership and ensure ongoing communication, (12) implement management, (13) monitor management and, if management is still needed, (14) identify new stakeholders and benefits and costs of the target species and (15) re-explore stakeholders' perceptions. Overall, this study aims to propose guidelines for effective engagement of stakeholders in invasive species management.

Keywords: conflicts of interest, stakeholders' ownership, perceptions, engagement, management of invasive species

Friday, 16 September 2016 - 14:00 - 14:45

Keynote 5 - Eradication, management & control of invasive species

Fr-K-05

Managing biological invasions in the Anthropocene

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In the Anthropocene invasion science and management are confronted with major new challenges: the scale of the problem is growing with increasingly more species being transported between continents, species move within biogeographic regions due to climate and land use changes (e.g. colonizing higher elevations in mountains or new habitats), native species can become problematic and alien species part of the solution, and natural areas are mostly surrounding by anthropogenic land exposing them more directly and immediately to invasion risks.

I will argue that the key for addressing these novel challenges is to reverse the division of labour between applied and basic research. Traditionally, in invasion science, we have first identified the biological principles driving biological invasions, then defined management needs and targets (e.g. lists of problematic species), and finally applied research and management was expected to work out the details of management strategies. More effective is to start with the management issues, develop a conceptual understanding of the different management problems, and derive specific research questions from such an understanding. Typical management problems are for instance: biosecurity, prevention and rapid response; strict protection of last “pristine” natural areas from invasions; low-cost maintenance and restoration of conservation-reliant nature reserves; landscape-scale management of coexistence landscapes characterised by mosaics of alien-species dominated and natural areas; management of novel ecosystems; or addressing global change impacts through the use of alien species, re-wilding, or assisted migration. By putting management problems first, the concerns and practical constraints of managers are taken serious from the beginning, multidisciplinary approaches involving natural, social and planning sciences become the rule, and we can develop an array of complementary and context-specific strategies that might seem contradictory (e.g. at once strict biosecurity or control of certain species and in certain areas *and* acceptance or even promotion of certain alien species in other situations) but will lead to more socially acceptable and effective management strategies. One solution for all problems approaches do not work anymore.

Keywords: biological invasions, management

Friday, 16 September 2016 - 14:45 - 16:00

Session 9 - Eradication, management & control of invasive species

Fr-S9-01

Cross-fertilizing weed science and invasion science: *Ambrosia artemisiifolia* as an ideal bridge species

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Weed science and invasion science have developed as two rather distinct research areas, with different institutions and researchers involved. This is partially due to the fact that the two disciplines indeed deal with different plant species, different target habitats and ecosystems, and that they are also committed to different stakeholders. Common ragweed, *Ambrosia artemisiifolia* is one of the economically most important invasive alien species (IAS) in Europe and elsewhere and constitutes an ideal species to create synergies between the “old” weed science and the “young” invasion science as it affects several sectors. It causes huge economic costs both for public health due to its highly allergenic pollen, for agriculture as it grows as a weed in many crops in Europe, where it is hard to control, as well as partially to biodiversity by colonizing habitats of high conservation value (e.g. tall herb communities, open forests) and spreading along linear transport structures (rivers, roads, railways).

We will outline how we, in the framework of an international research program, deliberately created synergies between very diverse fields of expertise to advance impact assessment and sustainable management of common ragweed European-wide. We first list differences in the setting, focus and strengths between weed science and invasions science and outline some early successes of inter-linking the strong points of these two disciplines. These include the elaboration of guidelines for habitat-specific integrated management of common ragweed, initiating studies on biological control candidates, linking plant occurrences to aerobiology and public health, the setup of a comprehensive economic ragweed impact assessment and management evaluation, and contributing to a European regulation of IAS and concerted trans-European action plans, especially focussing on biological control and on involving multiple

stakeholders. Finally, we highlight how the multi-forked “Ambrosia approach” can be used as a template for establishing international and interdisciplinary consortia towards (i) a comprehensive impact assessment, elaboration of efficient management options and subsequent success evaluation of IAS that impact various sectors, habitat types and regions, (ii) an interdisciplinary and more sustainable management of crop weeds in an agro-ecological context, and (iii) fostering novel insights into key ecological concepts related to species spread and management.

Keywords: ragweed, Ambrosia, management, international, biological control, health, weed, plant invasion,

Fr-S9-02

Environmental drivers of European-wide variation in *Ambrosia* pollen and seed production, and implications for management of this invasive, allergenic species

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The invasive common ragweed, *Ambrosia artemisiifolia*, is readily established in most European countries, *and in very diverse habitats*. This annual plant produces extremely high amounts of pollen and seeds, forming a reason of concern due to the highly allergenic properties of the pollen, and the adverse effects of the resulting high plant densities on crop production, respectively. To eventually better manage the species, it is vital to understand natural variation in pollen and seed production of *A. artemisiifolia* populations. We here first present the results of a study on the environmental factors driving pollen and seed production of *A. artemisiifolia*. In the framework of a European-wide research network, over 20 teams participated in an in-depth field study, including more than 40 *A. artemisiifolia* populations across the European continent, covering a wide range of climates and habitats. For each population we assessed the density and performance of *A. artemisiifolia* within subplots, and collected data on environmental variables likely affecting these properties. We show that variation in pollen and seed production varies largely both between, and within populations, resulting from variation in densities as well as in individual plant sizes. We compare the power of models at three different spatial scales (the region, the site, and the subplots) in explaining this variation. We found specific drivers at the scale of the site and the subplots related to the weather and the vegetation to be most important, and we discuss their implications for *Ambrosia* management. We then present demographic models of *A. artemisiifolia* parameterized by the field data, and integrate experimental data on new management strategies (vegetation management and biological control) to project the long-term effects of these strategies for different populations.

Keywords: common ragweed, invasive plant, health problems, field survey, plant performance, demography

Fr-S9-03

Long-term control of *Impatiens glandulifera* in a Swiss Forest: does zero-tolerance pay off?

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Himalayan balsam (*Impatiens glandulifera*), native to India, is an invasive plant in most European countries and negatively affects the invaded ecosystems. There are hardly any reports of long-term success in controlling this species. Therefore, it is unknown how much effort is needed to eradicate the species in specific ecosystems.

To test the efficacy of an intensive control procedure, an experiment was set up in 2012 in a small isolated forest (10 ha) in the Swiss midlands (375 m.a.s.l.), strongly invaded by *I. glandulifera*. We hypothesized that frequent weeding is key to prevent seed production and propagation by this species, which flowers from June to November. From 2012 to 2014 the forest was searched for *I. glandulifera* eight to nine times per year, and five times in 2015, pulling out all plants with the roots. The number of removed plants and working hours were recorded each time.

Results show a strong decline in the number of plants (from 101'000 ha⁻¹ in 2012 to 2'150 in 2013, to 25 in 2014, and to 4 in 2015). Assuming that 30'000 seeds were produced per m² in the original dense population (literature value) and no new seeds were produced after 2011, plant numbers in 2013-2015 indicate that more than 99.999% of the seeds from 2011 died, were eaten or germinated in 2012, whereas only 0.0007% survived until 2013 or longer.

The working effort per hectare for removing the plants declined from 104 h (2012) to 55 h (2013) to 48 h (2014) to 25 h (2015). The decrease rate was lower than in the number of plants because of the time needed to search the entire area. The effort cannot be reduced below a certain minimal level, which depends on the search area and not on the number of remaining plants.

Since a complete eradication of the population was not yet achieved in 2015, this project will be continued for another season. Results will demonstrate the feasibility and needed effort for a complete eradication through rigorous and frequent weeding and therefore help managers decide whether this is a suitable management strategy in similar forest ecosystems.

For a complete eradication it is crucial that all plants are removed and that none produces a single seed: zero-tolerance is necessary! This requires a high effort initially, followed by a smaller but continued control effort over several years (weeding every 3-4 weeks during the whole flowering period). We propose that it is more efficient to begin removal in a small area, but remove the invasive plant rigorously. Removing it in large areas only once or twice per year might be a waste of resources.

Keywords: *Impatiens glandulifera*, forest, management, eradication, control, effort

Fr-S9-04

Making the psyllid work: the biological control of Japanese knotweed in England and Wales as a study system to understand and manage biological invasions

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Japanese knotweed (*Fallopia japonica* (Houtt.) Ronse Decr. 1988) is an invasive perennial weed of Asian origin that is widespread in Europe and North America, where it causes serious economic and environmental damage. Conventional chemical and mechanical control methods are unfeasible because of the widespread distribution and frequent riparian occurrence of this species. Thus, classical biological control using a specialist antagonist from the native region of the weed was considered suitable as an alternative management method in England and Wales. A research programme carried out at CABI quarantine facilities revealed that the herbivorous insect *Aphalara itadori* Shinji (Homoptera: Psylloidea) is highly specific to Japanese knotweed. Based on these studies, the psyllid *A. itadori* was licensed for release in England and Wales. Three release phases have been made since 2010 including an intense monitoring programme mainly focused on any potential negative impact of the agent on Japanese knotweed and the receiving environment. Here we present the results of the release of *A. itadori* and the monitoring efforts carried out until 2016. The first two phases of the release (2010-2014) considered eight isolated Japanese knotweed stands. Despite the large number of adults released and the observation of eggs and nymphs at several sites, the establishment of the psyllid was not successful. The following release strategy (2015-onwards) builds on the theoretical framework of biological invasions and ecological theory to disentangle the different barriers the psyllid must face to establish viable populations in the wild. We review the studies done so far in the system *A. itadori* – *F. japonica* in relation to climate matching, biological interactions and propagule pressure to elucidate the potential limitations for the establishment of the psyllid and to propose further recommendations. This long term project shows how linking studies on biological control and biological invasions might provide a significant advance on our understanding of the invasion process and facilitate an integrated management approach.

Keywords: biological control, japanese knotweed, weed, aphalara itadori

Fr-S9-05

How to deal with cat (*Felis silvestris catus*) management on a large and inhabited island?

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Invasive populations of feral cats (*Felis silvestris catus*) strongly threatened wildlife on worldwide islands and particularly native species. Feral cats have invaded New Caledonia archipelago from seashore habitats to the highest altitude forest (1628m), most of these habitats harboring unique species assemblages. We have already demonstrated in a previous study that cat predation at archipelago scale is huge especially on reptiles (Frequency of Occurrence (FO): 42%) and flying foxes (up to 30% in some humid forests), most of them being endemic, and petrels (FO: up to 25% in some mountain areas). Here, we aim at mitigating cat impact on Pindaï peninsula (10 km²), located in the North of the New Caledonian mainland. We studied cat recolonization process by estimating cat population size before and after a feral cat control. We used camera traps as “capture” method and calculated 3 indicators: i) abundance index; ii) minimum number of individuals and, iii) individual capture histories using the spatially explicit capture-recapture (SECR) model to calculate density. Before feral cat control, we obtained 54.5 detections/100 camera trap-days from a total effort of 889 camera-trap days over 1 month. We individualized 25 feral cats from these pictures and the density calculated was 2.02 individual/km². Then, 35 feral cats were live-trapped for a total of 1240 trap-days over 2 months. Traps were checked twice a day and as soon as a cat was trapped the veterinary in charge proceeded to the euthanasia. 3 months after the end of feral cat control we obtained 43.32 detections/100 camera trap-days from a total effort of 1228 camera-trap days over 1.5 month. We individualized 28 cats and the preliminary density calculated was between 1.8 and 1.9 individual/km². Our study confirms camera-trapping as a useful tool to calculate the minimum size and density of a targeted cat population. This cat population has recovered, with almost the same amount of individuals, in only 3 months after the end of cat control. This recovery is mainly due to the colonization of new individuals that re-invaded this peninsula freed from most of resident feral cats. These results demonstrated a rapid recolonization process by feral cat leaving in close vicinity of this peninsula.

Keywords: feral cat, invasive predator, CMR analysis, SECR analysis, camera trap monitoring, trapping, invasive species control



Friday, 16 September 2016 - 16:45 - 18:30

Session 10

Eradication, management & control of invasive species

Topic continued from previous session

Fr-S10-01

Spread of *Vespa velutina* in Italy: natural diffusion, human-mediated dispersion and monitoring intensity to improve the management activities

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Vespa velutina Lepeletier 1836 is an Asiatic hornet species introduced in France in 2004. The species quickly colonized many European countries, such as Spain, Portugal, Belgium, Italy and Germany; in Italy first nests were discovered in 2013 in the northwest part of the country. *V. velutina* actively preys honeybees and wild insects, and could exert a negative impact on apiculture, natural ecosystems and human well-being. For these reasons, monitor and control activities recently started in Italy thanks to the work of many beekeepers and volunteers, together with a European Life Project (LIFE14 NAT/IT/001128 STOPVESPA) which aims to develop new tools and methods for controlling the species.

V. velutina could spread by natural diffusion or through passive transports of inseminated queens. In the first case the spread will be progressive and predictable, while human-mediated transports leads to the unpredictable colonization of areas even far away from the current distribution range.

Aims of this work are: *i*) reconstruct the spread of *V. velutina* since his arrival in Italy and establish a method to disentangle the natural diffusion from human-mediated transportation; *ii*) define buffer zones with different monitor and control intensity around the current Italian distribution range of the species with different likelihood of nests probability. The analyses were performed based on nests distribution, cluster analysis and nearest neighbour analysis of nests in respect to possible source sites of the previous year.

The range of the species increased exponentially from 205 km² in 2013 to 346 km² in 2014 and 930 km² in 2015 ($R^2 = 0.97$; $F = 32$; $p = 0.11$). The mean linear spread rate was 18.3 ± 3.3 km/year, and follows a linear trend ($R^2 = 0.99$; $F = 200$; $p < 0.05$). A cluster analysis of nests distribution allowed to identify 17 core-areas enclosing 90% of the nests in 57 km², with a mean nest density of 2.9-3.5 nests/km². Over this threshold the inclusion of others nest quickly increased the overall area.

Mean distances of nests observed in 2015 from possible source sites were used to define areas where the species could naturally spread in 2016. The estimated probabilities were: 33.5% within 500 m from the current range, 52.5% within 1 km, 75.1% within 2 km, 92.3% within 5 km and 97.7% within 10 km. Three expansion models were then elaborated at 700, 900 and 1200 m a.s.l., considering the altitude limits where nests and adults were observed.

These results could be used to improve the effectiveness of *V. velutina* control, and better focusing possible expansion areas.

Keywords: Asian yellow-legged hornet, domestic and wild bees, range analysis, species distribution, drivers and pathways, monitoring intensity

Session 10

Biosecurity and risk assessment, including early detection and rapid response

Fr-S10-02

EU Regulation on invasion alien species

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The EU Biodiversity Strategy [1] aims to halt the loss of biodiversity and ecosystem services in the EU and help stop global biodiversity loss by 2020. This Strategy sets out 6 targets, one of which is to combat invasive alien species. In implementation of this, the EU Regulation on invasive alien species [2] entered into force on 1 January 2015 (the IAS Regulation).

At the core of the IAS Regulation is a list of invasive alien species of Union concern (the Union list). Species for inclusion on the Union list are considered following a proposal of the Commission or the request by any of the EU Member States.

The European Commission is mandated to adopt and update the Union list as appropriate by following the criteria laid down in the IAS Regulation. In this, the Commission is assisted by a Committee in which the 28 EU Member States are represented. The Commission can only adopt the Union list and its updates with the positive opinion of this Committee. A Scientific Forum, with experts appointed by the Member States, is also consulted during this process.

The first Union list is expected to be adopted in the course of July 2016. Updating this list is an ongoing process and information on species under consideration for future updates can be found on a dedicated webpage [3].

The IAS Regulation foresees three types of intervention to be applied across the EU in relation to the species on the Union list: (1) prevention, (2) early detection and rapid eradication of new invasions, and (3) management of invasions that are already widely spread.

The European Commission progressively establishes an information support system necessary to facilitate the application of the IAS Regulation. The core of this system is the European Alien Species Information Network (EASIN) [4].

References

[1] <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0244>

[2] Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species: <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1465832789495&uri=CELEX:32014R1143>

[3] http://ec.europa.eu/environment/nature/invasivealien/index_en.htm

[4] <http://easin.jrc.ec.europa.eu/>

Keywords: EU Regulation, invasive alien species

Fr-S10-03

Consistency of impact risk assessments across assessors

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Risk assessments offer strong tools to managers and policy makers to support their decisions on problems caused by alien species. Risk assessments vary in their scope. While some focus on the probability of establishment or invasion, some also account for their potential to cause ecological or economic impacts.

Within the WP3 COST Action AlienChallenge we tested alien species from different taxonomic groups and habitats across several impact risk assessment protocols. In total 78 species (3 to 10 per taxonomic group) were assessed by 90 experts. Each species was assessed at least by 5 assessors.

We found a large divergence in species ranks among protocols. The consistency on species ranking was dependent on whether the protocol considered socioeconomic impacts or not. General knowledge about the species was negatively related to the consistency across assessors. In general results for freshwater species were more variable than for terrestrial species.

Keywords: risk assessment, impact, management

Fr-S10-04

Beyond protocols: improving the reliability of expert-based risk analysis underpinning invasive species policies

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Risk assessment tools for invasive alien species need to incorporate all evidence and expertise available. Despite the wealth of protocols now available to this end, we believe the current way of performing risk assessments shows several shortcomings and provide examples with regards to the newly implemented EU IAS Regulation. In particular, baseline data on ecological impacts, transparency in the decision making, uncertainty and content control should be properly considered for decision making. We recommend improved quality control through formalized peer review with clear feedback to authors and reviewers, and stress the importance of ensuring repeatability and transparency. Alternatively, to better capture opinions of different experts, thereby maximizing the evidential basis, a consensus approach can be applied which also provides inter-rater reliability. Manageability should also be explicitly covered in risk analysis. Tackling the invasive species issue requires better handling of the acquired information on risk and the exploration of novel methodologies for decision making on biodiversity management. Quality assurance, repeatability, clear procedures and transparent decision making are crucial for efficient conservation resource allocation and uptake by stakeholders and the public.

Keywords: evidence-based conservation, expert judgement, decision making, manageability, listing

Fr-S10-05

Prioritising surveillance for alien organisms transported as stowaways on ships

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As many alien and invasive species have been introduced to South Africa as stowaways, the vectors of these organisms need to be further managed. One such vector is global shipping which facilitates the transportation and introduction of both marine and terrestrial stowaway organisms. Ship movement data and seasonal environment matches were used to evaluate how the marine and terrestrial invasion risk posed by shipping to South Africa varies across shipping routes and seasons. Species distribution data were used to identify species that are known to be invasive elsewhere, and which might be introduced to South Africa through the shipping routes that pose a high relative invasion risk. Shipping routes from Asian ports, especially Singapore, pose a particularly high relative invasion risk to South Africa. Of the South African ports, Durban has the highest risk of being invaded. The relative invasion risk posed by the shipping routes to South African ports varied little across the seasons, but the relative importance of the routes changes seasonally. Our results indicate that port- and season-specific prevention strategies should be developed, and a large portion of the available resources should be allocated to Durban. The presented method provides a simple way to prioritise surveillance effort between ports of entry, shipping routes, and seasons.

Keywords: biological invasions, biosecurity, prevention strategies, marine environment, terrestrial environment, resource allocation

Fr-S10-06

Detection of invasive gobies by probing freshwater samples for DNA traces

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Ponto-Caspian gobies are a flock of five invasive fish species that have colonized freshwaters and brackish waters in Europe and North America. One of them, the round goby *Neogobius melanostomus*, figures among the 100 worst invaders in Europe. Current methods to detect the species involve catching or sighting the fish. These approaches are labor intense and not very sensitive. Consequently, populations are usually detected only when they have reached high densities and when management or containment efforts are futile. eDNA (environmental DNA) assays detect the presence of a species from the genetic traces it leaves behind in its environment. Typically, such assays require less time and less manpower and thus less financial resources than conventional monitoring methods, and are less invasive for the ecosystem. Therefore, we developed an assay to specifically detect DNA traces of Ponto-Caspian gobies in river water. We will present how sampling and experimental parameters greatly impact detection and will explain why eDNA assays by their nature can provide qualitative but not quantitative results. We will show how we successfully applied the assay to outline the invasion front of Ponto-Caspian gobies in a large river, the High Rhine in Switzerland. In summary, we introduce a functional assay that enables environment managers to quickly and cheaply map areas invaded by Ponto-Caspian gobies, independently of fishermen's' reports and of fish community monitorings.

Keywords: eDNA, detection, monitoring

Fr-S10-07

Parsing Propagule Pressure: The effects of multiple aspects of propagule pressure on the success of the invasive musk thistle *Carduus nutans*

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Propagule pressure explains the success of many biological invaders. It is typically thought of as composite measure of the number of non-native individuals released (intensity) at discrete events and the number of release events (frequency). However, additional aspects of propagule pressure may also play a role. Using a theoretical framework from disturbance, and thinking of propagule pressure as a perturbation of the existing community, suggests that timing and duration of propagule arrival may also affect invasion outcomes.

We demonstrate the utility of this framework in a study of the successful invasion of musk thistle (*Carduus nutans*) in the USA. We examined both intensity and frequency in conjunction with invasion timing, duration, and genetic diversity to determine their effects on local establishment of musk thistle in a large, multi-year field experiment. We also evaluated effects on survival, probability of reproduction and fecundity.

As expected, invasion success increased with intensity. However, the frequency of release events was not as important as their distribution in time. Contrary to expectations, genetic diversity had no significant impact on invasion outcomes in this study. Our results suggest that seasonal timing of propagule arrival may have a greater effect on establishment than previously realized. Furthermore, only considering one or two aspects of propagule pressure may provide a misleading view of the factors affecting invasion. Understanding the relative importance of multiple, interacting aspects of propagule pressure will be key to improved predictive ability for invasive species, and will also likely help to prevent future invasions.

Keywords: invasion, disturbance, propagule

Poster presentations

Topic 01

Biological invasions and climate change

P-01

Will Climate Change Impact Distribution of Common Ragweed in Turkey?

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Common ragweed (*Ambrosia artemisiifolia* L.) is noxious invader causing severe pollen allergies. Ragweed has extended its range over a considerable portion of the Turkey after its first record in 1998. Ragweed infestation in agricultural areas (particularly in sunflower fields) has recently been reported. The plant has become a detrimental threat to agriculture and human health in the country. Climate change will affect the distribution of ragweed and complicate the management of plant. Although Turkey is among the countries which are vulnerable to the expected climate changes, this is the first report to assess the impacts of climate change on potential distribution of ragweed in Turkey. In the current study, a process-oriented niche model was developed using CLIMEX software to map the potential distribution of ragweed in Turkey under different climate change scenarios. The data on the current distribution of plant was recorded through extensive surveys in the country. We used two climate change scenarios A₁B and A2 and climate data from two different sources CSIRO and MIROC-H. The model was run for current climatic conditions of 2030, 2050 and 2100. The results indicated that more than half of the country is vulnerable to ragweed invasion under current climate while, further spread was expected under climate change scenarios. The potential distribution area was increased in 2030 and 2050 while decline was observed in 2100. Expected warming is possible reason of range contraction in 2100. Ragweed can present severe agricultural and health concerns under changing climate up to 2050. The areas to North West of the country, which are densely populated, are more prone to invasion.

(This study was funded by TUBITAK with grant number 113 O 790 as a part of Cost Action TD-1209. The results also address the major challenges focused by Cost Action FA-1203)

Keywords: Common ragweed, potential distribution, climate change, Turkey

Diversity of the genus *Symphyotrichum* and trends of contemporary spread of its species in Lithuania

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The genus *Symphyotrichum* (Asteraceae) is native to North America and includes more than 90 species. In Europe, this genus is represented by 16 alien species. Taxonomy of the genus is extremely difficult, because European populations include plants that are products of artificial breeding in cultivation and spontaneous hybridization following escape. Two species of this genus, *Symphyotrichum novi-belgii* and *S. lanceolatum*, are mentioned in the list of 150 most widespread alien plant species in Europe, which occur in more than 25 regions. Several other species are already invasive locally or in certain European countries.

The analysis of plants collected during field investigations in 2013–2015 and the study of herbarium specimens revealed that in Lithuania the genus *Symphyotrichum* is represented by seven species: *S. dumosum*, *S. novae-angliae*, *S. pilosum*, *S. ×salignum*, *S. lanceolatum*, *S. novi-belgii* and *S. ×versicolor*.

Two species, *S. lanceolatum* and *S. ×salignum*, are the most widespread species of this genus. The first species is most frequent and abundant in North Lithuania, where it occupies habitats of river valleys and lake shores. *S. ×salignum* is mainly distributed in East Lithuania. Both species produce viable seeds. *S. novi-belgii* is somewhat rarer, though is distributed throughout Lithuania. This species as well as rather rare *S. novae-angliae* and *S. ×versicolor* occupy mainly anthropogenic habitats. Localities of *S. dumosum* are concentrated in East Lithuania. Generative reproduction of this very late flowering species has not been recorded yet. *S. pilosum* is very rare, recorded in two localities along the River Širvinta in Central Lithuania. It also occupies riparian habitats, produces viable seeds and further spread is expected. Particular geographical distribution of certain *Symphyotrichum* species is probably mainly determined by history of cultivation and less by natural conditions.

Late flowering plants of the genus *Symphyotrichum* in Lithuania and the Baltic Region were considered as non-invasive, because they produced seeds only occasionally. However, because of climate change during the last decades and, therefore, warm and much extended autumns, which sometimes continues till the end of November, generative reproduction has become more intense. These factors facilitate spread of several *Symphyotrichum* species. They invade almost all riparian habitats, various types of meadows and anthropogenic habitats. At least three species, *S. lanceolatum*, *S. novi-belgii* and *S. ×salignum*, are potentially invasive in Lithuania.

Keywords: Climate change, distribution, generative reproduction, habitats, invasion, spread.

P-03

Climate warming accelerates the life cycle of the invasive musk thistle (*Carduus nutans*)

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Climate change has the potential to alter the life cycles of many plants. Warmer temperatures can advance mother plants' phenology, causing earlier seed release and earlier germination of fall-germinating seeds. Warming can also extend the growing season later into the fall. Together these effects may increase the sizes to which seedlings grow in their first season. The demography of monocarpic perennials with size-dependent flowering may be particularly sensitive to these changes, as increased growth causes individuals to reach size thresholds for reproduction more quickly.

We investigated the effects of earlier seed release and warming on the life cycle of musk thistle (*Carduus nutans*) in a two-cohort field experiment with seven planting time treatments (ranging from planting in early August to planting in mid-November) and two temperature treatments (warmed in fiberglass open-top chambers and ambient).

Earlier planting resulted in larger rosette sizes at the end of the first growing season, which lead to a larger fraction of individuals flowering as annuals. Warming also increased the growth of rosettes. We modelled the impact of these changes on population growth rates using integral projection models. Together, increased growth and larger size of new rosettes are projected to dramatically increase the local population growth rate, indicating the potential for this invasive weed to become more problematic as warming progresses. These changes may also open new opportunities for improved management, for example via targeted mowing of flowering individuals.

Keywords: Climate warming, phenology, integral projection model, thistle, *Carduus nutans*

Will climate change increase range overlap between potential invaders and their native congeners in Europe?

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What determines whether a species becomes invasive or not is one of the central questions of invasion biology. Among the many factors involved, interspecific hybridization with native congeners, or with naturalized other closely related aliens, has recently been shown to clearly promote invasiveness, at least in plants. Such hybridizations of course require that the geographical distribution of species with their wild congeners actually overlap. With climate change, ranges of species are expected to change, and these changes might bring species in contact that have previously been isolated, or at least increase the overlap of their ranges and hence the hybridization risk.

In this paper we use species distribution models to predict how the overlap of climatically suitable ranges of a set of potential future invaders and their already present congeners will actually change under three scenarios of climate warming in Europe. Potential invaders were defined as ornamental species that are already cultivated in Europe and have naturalized in some alien ranges outside Europe, but not in Europe itself so far. From this pool of species we selected those genera where evidence for hybridization during invasions has already been provided in the literature and for which either native or alien congeners exist in Europe. We used the “area under the curve” and “Cohen’s kappa” as measures of overlap between the climatically suitable ranges of species. We hypothesized an overall increase in range overlap and hence in hybridization risk.

Our results did, however, not confirm our expectations. On average, the climatically suitable range of potential invaders in Europe increases, but the one of native congeners decreases. As a net balance, the amount of range overlap remains approximately constant. However, there is pronounced variation among genera and for some of them the increase in range overlap is actually considerable. As a consequence, while hybridization risk among invaders and their congeners does not generally rise, there are nevertheless individual cases where at least the contact between potential hybridization partners may strongly increase.

Keywords: biological invasions, climate change, hybridization risk, interspecific hybridization, potential future invaders, range overlap, species distribution models

Response of *Torymus sinensis* (Hymenoptera: Torymidae), a parasitoid of the invasive pest *Dryocosmus kuriphilus*, to olfactory and visual cues

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Torymus sinensis Kamijo (Hymenoptera, Torymidae) is a biological control agent of the chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera, Cynipidae), that has been successfully used in classical biological control programs in Japan (1975), the USA (in the late 1970s), Italy (2005), France (2011), Hungary and Croatia (2014-2015), Slovenia (2015). It is a univoltine species like its host. After early spring emergence and mating, the female lays eggs inside the larval chamber of newly formed galls, usually one egg per host larva. After hatching the larva feeds ectoparasitically on the host larva, and it pupates in the host larval chamber during winter.

The introduction of this parasitoid is widely known as one of the typical successful cases of classical biological control; however, the risks of the agent concerning potential negative effects on nontarget native oak gall inducers have never been evaluated thoroughly.

Relatively little is known about its host location and host acceptance behavior that was investigated by using a Y-tube olfactometer. Six days old, mated and unmated females were tested for their response to olfactory and visual cues associated with *D. kuriphilus* galls versus cynipid oak galls (*Biorhiza pallida* and *Andricus curvator*) and chestnut foliage versus oak foliage. Before the trials, the wasps were individually kept at room temperature without any host in a glass tube for 18 h with microdrops of honey to prepare the wasps to the experimental conditions. In the olfactory bioassays, the responses of parasitoid females were analyzed by a χ^2 test. The null hypothesis was that parasitoid females had a 50:50 distribution across the two odour sources. All analyses were performed using SPSS version 20.0.

Higher numbers of *T. sinensis* females were attracted to the chestnut galls compared to nontarget cynipid oak gall hosts. The same result was obtained in the case of different proposed foliage: the chestnut foliage appeared to be more attractive for *T. sinensis* females than the oak foliage (*Quercus robur*). The combination of olfactory and visual stimuli provided by a fresh gall coupled with chestnut foliage elicited the strongest positive response. Our results indicate that both visual and olfactory cues are required to enable *T. sinensis* to successfully find suitable hosts. These findings may enhance our ability to manipulate *T. sinensis* for gall wasp management.

Keywords: invasive pest, *Dryocosmus kuriphilus*, *Torymus sinensis*, classical biological control, parasitoid

Invasions of Waxwing *Bombycilla garrulus* in Polissya and Forest-steppe zone of Left-bank Ukraine

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Waxwing is a typical invasive species for Western Europe; its numbers depends on the harvest of berries and fruits. On the investigated territory, as well as within all Ukraine, birds migrate and winter, appear annually, however their amount differs on years and their appearance has more or less invasive character. During 2000-2015 in the Kyiv, Chernihiv, Sumy, Poltava and Kharkiv regions it was collected 100 phenological data personally and by means of questionnaire. When invasions occur Waxwings appear comparatively early, as a rule, in the second half of October - November, at once in great amount, and depart late - in March - April, sometimes stay later even till the beginning of May. In years with low numbers their autumn migration, as usual, takes place unnoticed and the first birds are often recorded already with the oncoming winter. They keep themselves in small flocks from few birds till some dozens of individuals. These years birds disappear unnoticed, often before calendar spring comes. In these cases in some sites they are difficult to be recorded. Autumn Waxwing arrival by regions: Kyiv: M = 18.XI, lim: 2.XI - 23.XI; Chernihiv: M = 26.X, lim: 10.X - 26.XI; Sumy: M = 29.X, lim: 10.X - 7.XI; Kharkiv: M = 18.XI, lim: 4.XI - 28.XI. Spring Waxwing departure by regions: Kyiv: M = 16.IV, lim: 5.IV - 9.V; Chernihiv: M = 24.III, lim: 15.II - 30.IV; Sumy: M = 28.III, lim: 26.II - 27. IV; Poltava: M = 25.III, lim: 14.II - 25.IV; Kharkiv: M = 20.III, lim: 5.III - 6.IV. During 2007-2015 81 flocks of birds were recorded in above mentioned regions. Low size of flock was 2 birds, maximal – 550. So average flock size is – 54.7 ± 10.4 , CV = 170.9% (n = 81). Usually, during migration flocks are about 100 and even more birds. In winter, when Waxwings are dispersed on the territories for searching food, the sizes of their flocks are usually smaller – 50-80 birds. The last large Waxwing invasion on the investigated territory took place during winter 2012-2013.

Keywords: invasions, Waxwing, Ukraine

P-07

Factors driving performance and distribution of *Ambrosia artemisiifolia* in the Czech Republic

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Ambrosia artemisiifolia, an annual plant native to North America, was unintentionally introduced to Europe in the 19th century. Because of its negative impact on human health, agriculture and biological diversity it is nowadays considered as one of the most dangerous European alien weeds. From the Czech Republic it has been known since 1883, up to the 1990s recorded in about 80 localities, while about 300 localities have been recorded up to now. Current distribution of the species is influenced by density of communication corridors, weather and land use and further spread is highly likely, supported by ongoing climatic changes and increasing propagule pressure due to the rapid increase in abundance of the species in a wider area of central Europe. As an annual *A. artemisiifolia* is crucially dependent on the successful performance of juvenile plants. Seedling growth and development are influenced by temperature and nutrient levels. The thermal window ranges from 10 to 34 °C, with the seedling growth being faster under higher temperatures and nutrient supply with maximum biomass under 30 °C. The temperature optimum is higher than that of some potential native competitors and this fact should be taken into account when choosing species for competitive mixtures developed to suppress *A. artemisiifolia*. *Bromus erectus*, *Lotus corniculatus* and partly also *Phleum pratense* were identified as the successful competitors in a competition experiment.

Keywords: plant invasions, seedlings, environment, temperature, salinity, nutrients, competition

Topic 02

Invader traits and characteristics of invaded communities

P-08

Life history of the invasive Chinese mitten crab (*Eriocheir sinensis*) in the Tagus estuary (Portugal).

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The aim of this study was to characterize Chinese mitten crab (*Eriocheir sinensis*, Milne Edwards, 1853) population structure and dynamics in the upper Tagus river Estuary, Portugal. *E. sinensis* bycatch was obtained on an approximately monthly basis for 13 months. Data was collected and analyzed regarding population structure, female gonad development, fertility, condition and growth. This population presented an overall sex ratio of 1.54 (M/F) but sex ratio oscillated substantially along the year and almost no females were captured during the period from January to April. From March to May there were ovigerous females, but most were captured during a period of high salinity (3-7 PSU) in May. Each ovigerous female carried a mean number of 36350 eggs and this is low in comparison to other areas where the species is present. A large percentage of crabs (44.4%) presented loss of appendages; 41% with leg loss and 5.9% with chelae loss. In conclusion, the population in the Tagus estuary is well-established, but is short lived and its females have an unusually low fertility. These particular population traits may help to explain the apparent absence of population explosions in this area. Nevertheless, we recommend a continuous monitoring program for this species due to the high number of impacts in other invaded areas and also because invader population densities can remain low for very long periods before exploding.

Keywords: Population dynamics, growth, sex ratio, fertility, Chinese mitten crab

Plant invasions in The Macizo de Anaga Biosphere Reserve, Canary Island: who and how is a relict ecosystem invaded?

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The Macizo de Anaga Biosphere Reserve is located at the north-eastern end of Tenerife Island and it spreads over an area of 48,727.61 hectares. Since 1987 it is a Natural Protected Area included in Natura 2000 Network. In June 2015, it has been accepted by UNESCO as a Biosphere Reserve. It gathers 196 species of flora of which 21 are local endemism. Today it is one of the main leisure areas in Tenerife, a fact that has helped to retain the local population and their way of life, while enhancing their living conditions.

As human land uses provide propagules for colonization by alien species, one of our most important concerns was to know the amount of alien species that invade, their distribution and critical areas, the invasiveness of the different ecosystems and the future pathways of dispersal.

To achieve these objectives, we made 189 inventories all over the Reserve. We studied the bioclimatic conditions of the area (bioclimatic belts: thermotypes and ombrotypes), the exposition, the slope, the altitude and the different types of ecosystems. In all, 46 variants were analyzed. Eventually, we also revise the historical record related with the introduced species, checking the Herbarium TFC (University of La Laguna) and many other references. According to legal regulations, invaded area size and invasiveness status criteria, we selected the higher impact species, understanding these as the ones that submit a high invasiveness capacity, rapid dispersal and type of habitat invaded. As a result, we apply the Geobotanic Information System (GBOTIS, Martín Osorio *et al.*, 2005) to obtain 79 maps of real and potential distribution.

Our findings pinpoint that of the 78 introduced species identified, 10 can be considered as higher impact species: *Opuntia maxima*, *Ageratina adenophora*, *Agave americana*, *Arundo donax*, *Ricinus communis*, *Oxalis pes-caprae*, *Pennisetum setaceum*, *Nicotiana glauca* and *Opuntia dillenii*. Altitude is the variable that has more influence on the invasion process. On the other hand, the warmest bioclimatic belts (upper and lower inframediterranean), riparian ecosystems (*Rubio-Salicetum canariensis*) and disturbed or successional plant communities (*Artemisio thusculae-Rumicetum lunariae*, *Rubio periclymeni-Rubetum* and *Myrico fayae-Ericetum arboreae*) are representative variables that are related with the invasion.

We conclude by outlining that early warning and early intervention systems are key strategies to tackle the spread of invasive species. We believe our results can be the account of a successful strategy to control/eradicate them.

Keywords: Geobotanic Information System, GBOTIS, bioclimatic belts, invasiveness, higher impact species

Changes in valve movement behaviour of the zebra mussel *Dreissena polymorpha* associated with the impact of biotic environmental factors.

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Zebra mussel *Dreissena polymorpha* (Pallas, 1771) is one of the most invasive species in the world, mainly due to its tolerance to a wide range of different environmental factors. Though there are many studies on its behaviour, only few of them concern the pattern of opening and closing the valves. Even those only deal with mussel responses to the presence of anthropogenic substances (environmental pollution). We assumed that zebra mussels are also capable of specific reactions to various biotic factors.

The aim of our research was to show how they react to the presence of kairomones of a predator (roach *Rutilus rutilus*) and alarm substance (secreted by injured conspecifics). We supposed that the scent of fish and alarm substance would be able to activate stress reactions (reduction in the overall time spent with open valves and induction of specific reactions, such as short opening periods or prolonged closure of valves to reduce the contact with the external environment). Besides, we expected different reactions of zebra mussels to the scent of fish whose diet contained *D. polymorpha* or not (the latter fed with larvae of chironomids).

We conducted all experiments in laboratory conditions using individuals collected from the Włocławek Reservoir (Central Poland, the lower Vistula River). The trials were recorded and then analysed with the specialised software for studying animal behaviour, Noldus Ethovision®XT. It follows the position of a colour mark on the movable mussel valve, resulting in a time series of percentage valve openings (relative to the maximum gaping).

We proved that the zebra mussel did not exhibit any specific reactions to the scent of roach itself. On the other hand, we noticed a strong response to the conspecific alarm substance, which may be the manifestation of behaviour related to a direct danger (the presence of a predator foraging at the moment, resulting in the production of conspecific alarm signals). Only in this case we observed relatively shorter time spent with open valves compared to the other variants, as well as the decrease in the mean percentage gaping. Thus, the valve movement response of the zebra mussel to predation pressure is based on the presence of conspecific alarm cue, rather than on predator identity, which makes it suitable to react to unknown danger sources in novel environments.

Keywords: *Dreissena polymorpha*, kairomones of predator, alarm substance, valve movement behaviour

Experimental effects of multiple regulating factors on cladoceran species richness and community structure

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Our goal was to determine how multiple environmental factors (e.g. resource levels, predation, cyanobacteria, and alien species) interact to regulate zooplankton communities in experimental aquatic food webs. We conducted several mesocosm experiments where we manipulated the presence/absence of alien large bodied cladocerans, zebra mussels, and fish under three levels of nutrient enrichment - mesotrophic, eutrophic and hypertrophic. Fish shifted the ratio between small and large bodied cladocerans in favour of small bodied species compared to controls. Fish also appeared to promote increases in cladoceran diversity through the coexistence of several smaller bodied taxa. Fish and nutrient enrichment increased blue-green algae and total chlorophyll concentrations. In contrast to fish, zebra mussels helped to promote the success of the large bodied alien *Daphnia*, but reduced the biomass of small bodied cladocerans. Population growth rates of large bodied species increased in the presence of zebra mussel, while growth rates of small bodied species decreased. Biochemical and elemental analyses demonstrated that zebra mussels reduced both the carbon(C):phosphorus(P) ratio and the concentrations of eicosapentaenoic acids (EPA) of the phytoplankton in the zebra mussel mesocosms. However, while EPA concentrations did not limit *Daphnia* growth rates, it did appear as though the C:P ratio in the zebra mussel treatment was below the range of their threshold values in control mesocosms. Therefore, an increase in the phosphorus concentrations of the seston may have favored the relatively P limited *Daphnia* in the presence of zebra mussels. Indeed, *Daphnia* biomass was the greatest in the treatment where zebra mussels were present. Combined, our results highlight the complex interactions of multiple factors that help to regulate zooplankton communities and size structure. Our research suggests that algal food quality may be an important factor regulating zooplankton communities and additional research is needed to better understand how food quality interacts with other important regulating factors.

Keywords: alien species, large and small bodied cladocerans, invasion mechanisms, PUFA, C:N:P ratios

Effect of cultivating conditions on plant-soil feedbacks of alien *Impatiens* species

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Plant-soil feedback, i.e. the relationship in which the plant affects the composition of the soil and such modified soil affects growth of the plant, can possibly be one of the key factors affecting plant invasiveness. While majority of plants show negative intraspecific feedback, positive intraspecific feedback is expected in invasive species that escaped their natural species-specific pathogens which thus cannot be accumulated in the soil and cannot negatively affect plant growth.

Positive (or less negative compared to natives) intraspecific feedback between invasive plant species and soil was demonstrated for several invasive species. However, in many studies no pattern like this was observed. A possible explanation for this inconsistency in the results might be the fact that the experiments are done under suitable conditions. Being in suitable conditions might mean that the plant is performing well even though the soil, in which it is cultivated, might be somewhat unfavourable.

To investigate the effect of cultivating conditions on results of plant-soil feedback experiments, we planted five alien *Impatiens* species in two-phase garden experiment. In the first phase, soil was cultivated by each of the species or left uncultivated. During the second phase, plants were grown in soil cultivated by the same species and in control uncultivated soil, both under four different cultivating conditions (two levels of watering x two levels of shading).

The feedbacks for total, above-ground and below-ground biomass and for root-shoot ratio were significantly affected by cultivating conditions. In three of the studied species, the feedback turned from negative to positive under certain conditions, however, these conditions differed among species. No effect of cultivating conditions on the feedback for germination was observed, with all plants germinating approximately the same in both cultivated and control soil.

Our results indicate that cultivating conditions play an important role in plant-soil feedbacks and that they should be considered in experimental designs. Multiple cultivating conditions or conditions closely resembling conditions in natural sites should thus be used to increase the realism of the results.

Keywords: plant-soil feedback, cultivating conditions, *Impatiens*

Untangling the complexity behind invasion success with an individual-based model

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Whether ecological communities assemble according to random processes – as predicted by neutral theories – or by repeatable, trait-based processes – as expected by niche-based theories – holds important implications for prediction in ecology, including biological invasions. Invasion biology has historically seen a focus on niche-based hypotheses, such as the enemy-release; novel weapons; and biotic resistance hypotheses, which invoke interactions and relationships between invaders and natives to explain invasion success (or failure). However, evidence in support of these niche-based hypotheses has been uneven and declining over time. Conversely, support has been mounting for neutral theories, particularly for the role of propagule pressure. Further, recent work suggests fundamental limits to the predictability of invasion dynamics due to inherit demographic stochasticity arising from repeated founder effects. Nonetheless, niche-based hypotheses remain important on a case-by-case basis. We have come to recognize invasions as complex, context-specific processes with no single explanatory factor to explain spread dynamics or invasion success. Future research needs to tease apart this complexity by focusing on the contributions of different properties of the invader, different properties of the recipient environment, and propagule pressure to invasion success at different stages of invasion and in different environmental contexts.

Few studies consider more than one or two hypotheses of invasion success, explicitly include transport processes, or couple pre-entry and entry processes with the post-entry stages of invasion. Individual-based models (IBMs) are well-positioned to address these challenges simultaneously because they: a) can easily incorporate idiosyncrasies endemic to different systems, b) can quantify stochasticity, and c) incorporate individual-level variation (e.g. in exact spatial arrangement). Here we present the development of a new spatially-explicit IBM. The model is designed to address the challenge of untangling multiple hypotheses of invasion success simultaneously. We do this using a distance model approach to model biotic and abiotic interactions, which are mediated by the resource budgets of individuals. Salient traits and processes are coded in a modular fashion, and can readily be added or removed depending on the system of interest. Invasive leguminous trees (Fabaceae) will be used as study species to evaluate our model.

Keywords: niche, community assembly, ibm, agent-based model, abm, invasion success

Germination and seed viability of common ragweed (*Ambrosia artemisiifolia* L.) influenced by seed dimensions, origin and age

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Common ragweed (*Ambrosia artemisiifolia* L.) is an annual Asteraceae species native to North America, which is highly invasive across Europe and has harmful impacts on a range of sectors, especially human health and agriculture. Especially its production of variable sized seeds is regarded as promoting its spread in different environments. In general, the seeds of common ragweed are dormant at maturity innately (primary dormancy) and require moist chilling (stratification) to come out of dormancy. Experiments with 12 Austrian populations of common ragweed were carried out to determine the influence of seed size (length and width), seed weight, seed origin and seed age on germination capacity. In addition, 2,3,5-Triphenyltetrazoliumchloride (TTC) tests were executed to determine the viability of the non-germinated seeds and to observe a possible correlation between morphological traits and the dormancy of seeds of common ragweed.

Generally, the TTC assay is a fast evaluation for seed viability. All respiring tissues are capable of converting a colourless compound to a carmine red coloured water-insoluble formazan by hydrogen transfer reaction catalysed by the cellular dehydrogenases. TTC enters both, living and dead cells but only living cells catalyse the formazan. Since a proper classification of intermediately coloured seeds (Fig.1) is still a challenge when determining viability rates (Starfinger et al. 2013) additional experiments were carried out on the basis of a joint-trial which was executed by 8 labs in 8 European countries using 4 populations of common ragweed to test the viability of the seeds by using TTC. Due to significant differences between the results of the various testing labs/persons, the 12 Austrian populations mentioned above were used for TTC testing to get a precise adjustment of the testing method as well as tight guideline for interpreting the results.



Fig. 1: Only living cells catalyse the formazan in TTC tests (Fotos: Hall)

Keywords: 2,3,5-Triphenyltetrazoliumchloride, seed bank, ageing

Does past competition affect invasiveness? Genetic differentiation and maternal effects in response to competition in an annual grassland species in its native and invaded range

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For an alien plant, the probability to establish successfully in a new range depends on its traits as well as on the biotic and abiotic characteristics of its new environment. Within species, traits can vary significantly, oftentimes leading to a match of a population's trait range with the respective environment. Population differentiation may thus lead to differences in the abilities of offspring to establish in a new environment. As for plants, competition is an important factor shaping species assemblages as well as population dynamics, the competition experienced in a specific population in the native range may influence the abilities of offspring from this population to establish in a new range.

The presentation will introduce results of a set of glasshouse experiments with the annual grassland species *Erodium cicutarium*. This species is native to Europe, and occurs as invasive alien species in many parts of the world, among them North America. We sampled populations in Germany and California differing in the level of competition experienced in the field, and grew these seed families in the glasshouse. Preliminary analyses indicate that the populations differ in how plants respond to shading in the greenhouse. One experiment, specifically addressing the effects of shading in the maternal environment on trait expression in the next generation, indicates that past competition triggers maternal effects. Two other experiments indicate the existence of genetic differences among the populations, leading to differences in the abilities of the offspring to respond to shading.

The results of the greenhouse experiments will be related to field data, and we will discuss in which situations past competition increases the probability for establishment success via maternal effects or genetic differentiation.

Keywords: Competition strength, context dependence, invasiveness, invasibility, novel interaction, ecological novelty, eco-evolutionary experience

P-16

What causes alien aquatic plants to become invasive?

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Invasive alien aquatic plants (IAAPs) cause significant ecological and economic impact. The number of introduced plants which become invasive is much higher for aquatic than for terrestrial plants. For aquatic plants, some studies provide detailed information on the biology of alien aquatic invasive species, but only a few traits have been reported as closely linked to successful aquatic plant invaders. However, a comprehensive knowledge of plant traits which are linked to aquatic plant invasiveness is still lacking. Moreover, some factors which will have most likely had an effect on the invasive success of alien aquatic plants have been almost neglected in the past. During this talk, introduction pathways, spread mechanisms (both sexual and asexual), growth characteristics (growth forms, growth rates, habitat requirements) and physiological attributes (light and temperature optima, carbon concentrating mechanisms (CCMs)) of IAAPs will be presented. Recent findings give some new insights into these attributes linked with the IAAPs success and will help to identify potential IAAPs in the future.

Keywords: Invasive aquatic plants, growth, spread, physiology, characteristics

Density of prey as a factor modifying the anti-predator behaviour of amphipods

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To minimize predation efficiency, prey uses diverse strategies, from simple defences, when only one aspect of behaviour is modified, to complex mechanisms, such as grouping involving simultaneously the dilution, encounter-dilution and predator confusion effects. The majority of research does not take into account the fact that the anti-predator strategy may vary depending on the density of conspecifics in the environment.

We studied the anti-predator strategy (including aggregation behaviour and locomotion) of an invasive gammarid *Dikerogammarus villosus* (Amphipoda, Crustacea) at different densities (5, 10 and 15 individuals per an area of 0.025 m²) in the presence of kairomones of a fish predator: the racer goby *Babka gymnotrachelus*. Furthermore, to check the effectiveness of the gammarid anti-predator behaviour, we exposed them under similar conditions to fish predation.

At the low density (low probability of conspecific encounters), gammarids responded to predators by moving over longer distances. In contrast, the decrease in moved distance was noted at the highest density, when the aggregation level was significantly higher than at lower densities. Moreover, gammarids always increased their aggregation level in the presence of predators. Gobies most effectively foraged on immobile single gammarids. Their predation efficiency was reduced at the highest gammarid density. Fish preferred single gammarids over aggregated individuals.

To summarize, gammarids respond to predators by modifying their movement, which, depending on the density-related possibility of conspecific encounters, leads to leaving a predator area at low density or finding conspecifics and staying in an aggregation at high density. Both these options were effective defence strategies.

Our study was supported by a grant of National Science Centre 2013/09/N/NZ8/03191.

Keywords: anti-predator behaviour, group living, *Dikerogammarus villosus*, flexible defence strategy, foraging, predator kairomones, predator-prey interaction

Estimation of seed longevity in artificial soil seed banks of common ragweed (*Ambrosia artemisiifolia*)

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Two experiments, started more than 100 years ago in the US, have shown that seeds of common ragweed (*Ambrosia artemisiifolia* L.) can survive up to 39 years in soil seed banks. Since no data are available for alien European ragweed populations, the HALT-*Ambrosia* team set up a long-term experiment to test ragweed seed longevity from different origins buried at 2 depths at 5 locations in Europe. Seed lots from Hungary (Kaposvar 2010) were buried in each country; additionally, a second seed lot from other origins was buried at each site: Germany used seeds from Domsdorf (Germany 2010); Austria and Hungary used seeds from Hagenbrunn (Austria 2011); Denmark and Slovenia used seeds from Unterpurkla (Austria 2010). In the winter 2011/12 seeds were buried at 5-8 cm and 25 cm depth respectively in fields or lawns in the surrounding of Vienna (Austria), Braunschweig (Germany), Kaposvar (Hungary), Flakkebjerg (Denmark) and Ljubljana (Slovenia). Fifty seeds were put in fine mesh polyethylene nets and buried at the two soil depths. Every year in early spring until 2022 a randomly chosen subset of five polyethylene nets per depth and origin were/will be dug out. Intact seeds are counted and tested for viability by germination test (wetted in petri dishes, 12h light at 25°C, 12h darkness at 15°C) for 4 weeks; the remaining not germinated seeds are subsequently tested for viability with the TTC-test. Germinability was expressed as percentage of initial number of seeds.

In the first year (spring 2013), the excavated seeds from Kaposvar still showed relatively high viability rates of 40-97% (mean of 88% at soil depth 5-8 cm) and 48-98% (mean of 89 % at soil depth of 25 cm). The seed lots from Hagenbrunn lost viability (35-82% at 5-8 cm depth and 38-89% at 25 cm), similarly as the seeds from Unterpurkla (23-42% at 5-8 cm depth and 19-43% at 25 cm). Mean survival rates of the Domsdorf seeds were 91% at 5-8 cm and 98% at 25 cm depth. The laboratories tried to follow the manual as strictly as possible; nevertheless, variation in the estimation of viability between the labs was relatively high.

Data from subsequent years (2014, 2015) showed less variation between laboratories. The trend observed in the first year that Kaposvar seeds survived at higher rates than the other seed lots continued. The differences in ragweed seed survival with respect to burial depth tends to increase with duration of burial, but without significant differences up to now.

Keywords: *Ambrosia artemisiifolia* L., seed burial, germination, viability, TTC-test

Intraspecific plant-soil feedback as an explanation of plant invasiveness

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Intraspecific plant-soil feedback is a relationship in which plant affects the composition of the soil and such modified soil affects growth of the same plant species. This relationship and its intensity may be linked with plant dominance and invasiveness. Dominant species can alter the composition of the soil in their favour and thus show positive intraspecific plant-soil feedback. As the invasive species are commonly being dominant in their new environment, it can be expected that intraspecific positive plant-soil feedback could be an important factor allowing the invasive species to achieve their dominant position and become invasive.

To test if the existence of positive intraspecific feedback could be a general mechanism underlying plant invasiveness we compared intraspecific plant-soil feedback in a group of invasive and introduced, but non-invasive, plants in the Czech Republic. We did this using a preselected set of 23 introduced species, which were planted in soil with their own history and in unaffected soil and then compared. More species will be tested in the future.

Seven of the twenty-three tested species responded significantly to the type of soil in terms of growth, but only *Conyza canadensis* showed positive intraspecific feedback. These seven species are both invasive and non-invasive. Seed germination was, however, strongly influenced by soil type - thirteen of twenty-three species have higher germination in the affected soil. The results thus suggest that positive plant-soil feedback may be more common for germination than for subsequent plant growth. Data on more species are needed to properly assess differences in feedback between invasive and non-invasive introduced species.

Keywords: plant-soil feedback, plant invasiveness

Interspecific competition as a factor modifying the spreading rate of invasive Ponto-Caspian gammarideans

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Several species of Ponto-Caspian gammarids have invaded main European waters, affecting benthic communities by predation and competition. The ranges and dispersal rates of particular species vary across Europe, which may result from their interspecific interactions, accelerating or reducing migrations. We checked this hypothesis by testing the interference competition among three co-occurring invaders: *Dikerogammarus villosus*, *D. haemobaphes* and *Pontogammarus robustoides*.

We used 140-cm long tanks (with gravel substratum providing shelters for the gammarids), divided into seven compartments along the tank length. We introduced 25 “residents” into the outermost compartment, separated with a barrier. After 1h, we introduced 25 “intruders”. After the next 1h, we removed the barrier and the gammarids could disperse in the tank. After 4 or 20h, we counted the gammarids in particular compartments. We tested all pairwise species combinations and single-species controls.

D. villosus had significantly displaced the other species (*P. robustoides* only after 4h) and reduced its own motility after 20h in their presence. *P. robustoides* stimulated the short-time migrations of *D. villosus* intruders and of all *D. haemobaphes* individuals. As *P. robustoides* migrated spontaneously much more than *Dikerogammarus* spp., its impact on the other species decreased after longer time. *D. haemobaphes* stimulated the short-time movement of *P. robustoides* intruders but reduced the long-time relocation of this species and that of *D. villosus*.

In general, the dispersal increased in the presence of stronger competitors (*D. villosus* and *P. robustoides*, especially introduced as residents) and decreased in response to weaker competitors (*D. haemobaphes*). The stimulation of dispersal was probably caused by competitive displacement by stronger competitors. The reduction of migration might have resulted from the increased defence of currently occupied shelters by the stronger species or from decreased competitive pressure of heterospecifics compared to the intraspecific competition. Thus, competitive interactions may affect the dispersal of invasive gammarids and contribute to the fastest spread of the weakest competitor, *D. haemobaphes*, whereas the strongest species, *D. villosus* would be the latest newcomer. Such order of appearance was observed in the field in the central migration corridor for the Ponto-Caspian fauna, including the Dnieper, Prypiat, Bug and Vistula rivers.

Our study was supported by National Science Centre grants 2011/03/D/NZ8/03012 and 2012/05/B/NZ8/00479.

Keywords: *Dikerogammarus*, *Pontogammarus*, competitive displacement, spread rate, interspecific interactions, freshwater environment

Biotic barriers to naturalization: a weak force or simply not adequately detected?Richard Mack*School of Biological Sciences Washington State University Pullman, WA 99164 USA, Pullman, United States*

Immigrants' naturalization and even subsequent invasion in a new range through escape from native enemies has long been recorded. In contrast an alternative outcome is poorly documented: the immigrants' (or their descendants') extinction by a diverse array of biotic agents (e.g., parasites and predators) native to the new range. How important are native organisms as biotic barriers to naturalization? Current attempts to comprehensively examine and quantify this issue have been restricted to the literature surveys readily available from Internet websites (e.g. Agricola, CAB abstracts, Web of Science). Reasons for the failure of such web-based searches to accurately gauge the effect of organisms acting as biotic barriers to naturalization include *i*) many web-based abstracting services do not record articles that pre-date 1900 or the internet, *ii*) examples in the grey literature can be difficult to detect or go unreported altogether, *iii*) web-based searches for examples of biotic barriers often encompass only ecological journals and overlook sources further afield (e.g. agronomy, entomology, fisheries, parasitology, plant pathology, and veterinary pathology). An especially relevant and as yet largely untapped discipline for investigation is forestry, particularly tropical forestry. Tropical foresters at the end of the 19th and beginning of the 20th century diligently attempted to introduce merchantable tree species into new ranges. Many of these trials failed repeatedly; tropical foresters were diligent in recording the outcome and the apparent cause of plantation failures in now defunct local journals. Furthermore, recording even a fraction these on-going extinctions, whether in deliberate field trials or through anecdotal observation in nature is not widely practiced today. As a result, evidence of the strongest and swiftest-acting biotic barriers soon disappears, i.e., the immigrants die and decompose without detection.

Keywords: predators, parasites, web-linked searches, tropical forestry

Does phylogenetic distance between invasive and native plants matter?

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In the field of (plant) invasion biology one of the major goals is to determine the factors that allow an alien species to become invasive. The phylogenetic distance of an invasive plant to the native community may play a role in its establishment success in that community. Alien plants more closely related to native plants may suffer more from competition, because of increased niche overlap (Darwin's naturalization hypothesis). On the other hand, relatedness and similarity in niche requirements can be linked to preadaptation, and thus could facilitate invasion.

To assess the role of phylogenetic distance in the establishment success of alien plant species, we used an already existing dataset, where alien plant species were introduced in grassland sites in Switzerland.

We calculated three phylogenetic distance measures:

- (1) the mean phylogenetic distance to all resident native species,
- (2) the phylogenetic distance to the most abundant resident native species, and
- (3) the phylogenetic distance to the nearest relative among the resident native species.

Overall, we found that alien plant species closer related to the native community are less successful than distantly related species.

Keywords: Darwin's naturalization hypothesis, alien plants, invasive plants

Epiphytes invasive species on the Canary Island date palm (*Phoenix canariensis* H. Wildpret) in the Canary Islands and Andalusia, Spain.

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Over the years we carried out a study and monitoring of epiphytes vascular plants installed naturally in the trunk of the Canary Island date palm (*Phoenix canariensis* H. Wildpret).

The Canary Island date palm is an endemic species of the Canary archipelago distributed by the world as an ornamental plant. In the Canaries their artificial distribution extends from sea level up to 1000 m.s.l.

Exceptionally some specimens have reached 1600 m (Vilaflor, Tenerife). There are some semi-anthropic palm groves that are renewed naturally.

Epiphytism on the palm tree has been detected in over 2000 specimens from near sea level on coastal walks to those in the midlands. At these altitudes they are subject to the humid climate of the trade winds and there are a high number of epiphytic species of cyanobacteria, briolichenic communities and even some Basidiomycetes.

Until now we have recorded some eighty different vascular species established on the stipe phorophyte mentioned.

In this communication the high presence of three invasive species is pointed out: *Ficus microcarpa* L., *Ficus rubiginosa* Desf. ex Vent., and *Nicotiana glauca* Graham.

Keywords: Epiphyte, *Phoenix canariensis*, Palm tree, *Ficus microcarpa*, *Ficus rubiginosa*, *Nicotiana glauca*

Can functional traits be used to predict plant invasion potential on a Sub-Antarctic Island?

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Non-indigenous species are a major conservation threat in the sub-Antarctic region, where the small size and low diversity of the islands render them vulnerable to biological invasions. However, what determines whether alien arrivals become successful invaders or not has not been explored for the region. We used a trait-based approach to understand whether the success of invasive plant species can be explained by differences in functional traits between indigenous and alien plant species. A number of functional traits of all alien and indigenous higher plant taxa on sub-Antarctic Marion Island were collected from different vegetation types, substrates, aspects and altitudinal gradients using a stratified sampling design. The value of each trait was averaged per species. To test whether native, non-invasive alien and invasive species differ in their functional traits, general linear models were performed for height, leaf area, specific leaf area (SLA) and electrolyte leakage as an indicator of frost sensitivity. Our findings showed that only SLA differed significantly between the three status groups. However, when phylogeny was accounted for by fitting a phylogenetic generalised least-squares model, all of the four traits analysed differed significantly for native, non-invasive alien and invasive species. A key finding was the high SLA and low frost tolerance shown by invasive species in this study relative to native and non-invasive alien species. These results suggest that invasive species have a capacity for faster growth rates and enhanced resource acquisition due to high SLA. This may predispose species to become invasive by allowing them to efficiently outcompete extant vegetation. High SLA also corresponds with relatively low investment in leaf defences, this is demonstrated by the low frost tolerance shown by invasive species in this study. The consequences of this finding are worrying for Marion Island, given that Marion Island has become considerably warmer; with this trend expected to continue into the future, we may expect invasive species to spread as conditions will become milder and so more suitable for a range of plant species. In summary, understanding which functional traits favour invasion success and potential may provide a useful tool to minimise future invasions.

Keywords: Plant functional traits, Invasive species, Marion Island, Sub-Antarctic islands, SLA

Do various types of forests differ in alien species composition?

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So far only few studies focused on alien species in forest ecosystems, as forests appeared to be more resistant to invasions. Recent studies revealed that it was only a temporary phenomenon and many forest habitats are continually being invaded by alien species.

The aim of our study was to find out how various type of forest habitats in Slovakia differ in the species composition of alien species. For the purpose of this analysis we have used database of forest relevés, included in the Central database of phytosociological relevés of Slovakia together with newly collected relevés that consisted of 10,392 relevés. From the original dataset we have omitted relevés of extreme sizes and relevés collected before 1960. Resulting database consisted of 5748 relevés. Relevés were classified within one of 23 EUNIS habitat types, based on the syntaxa, where they belonged. Vascular taxa were classified as either native or alien (archaeophytes, neophytes), based on the Inventory of alien flora of Slovakia (Medvecká et al. 2012). Fidelity and frequency of the species, calculated by software JUICE (Tichý 2002), were used to compare occurrence of various (most frequent) alien species in the analysed habitats.

This will help us to find out:

- i) whether some of the forest habitats possess specific alien species combinations and
- ii) whether various alien plants prefer some specific forest habitats.

Some of the forest habitats contain several alien species with rather high fidelity, such as *Robinia pseudoacacia* plantations with several species of archaeophytes (e.g. *Anthriscus cerefolium*, *Bromus sterilis*), or Riverine *Salix* woodlands with several species of invasive neophytes (e.g. *Aster novi-belgii*, *Acer negundo*). On the other hand, some species, such as *Impatiens parviflora*, are frequently found in various types of forest habitats and are not bound to any of them. The results will serve as valuable scientific base for the qualified forest management especially in the protected regions.

This contribution was supported by grant VEGA 2/0051/15.

Keywords: EUNIS, fidelity, invasive plants, archaeophytes, neophytes

Archaeophytes vs. neophytes: which are more successful invaders in high mountain?

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Mountain ranges are biodiversity hotspots and home of many endemic, rare and endangered species, which are being continuously affected by climate change, eutrophication and human-induced disturbance. As a result, they are getting more susceptible to invasions by alien plants.

The aim of the presented study is to evaluate characteristics of non-native plants of the Tatra Mts, and to analyse patterns of their distribution, especially with respect to the different residence times of the alien plants. The distribution data of alien species were collected during years 2009-2011 along the tourist routes in mountain valleys, along main roads, along railways, and in the surrounding of mountain chalets.

Together we have found 51 alien taxa in the Tatras – 20 neophytes and 31 archaeophytes. Majority of alien species, found in the Tatras, is widely distributed and abundant in Slovakia and occurs in most of the phytogeographic regions. Alien species that were more frequent in the Tatras, reached also higher altitudes. Altitudinal maxima of archaeophytes and neophytes and their frequency in the Tatras did not differ significantly, indicating that even though archaeophytes had more time to spread in the region, the mountain conditions were not suitable for majority of them, as they prefer different ecological conditions. Our results suggest that even though we have recorded more species of archaeophytes than neophytes, both of them seem to be almost equally successful invaders in the Tatra Mts.

This research was funded by VEGA 2/0098/11, VEGA 2/0121/09 and VEGA 2/0090/12.

Keywords: alien plants, plant invasions, altitude, Tatra Mts, Central Europe

Effects of seed traits variation on seedling performance of the invasive weed, *Ambrosia artemisiifolia* L.

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Seedling performance can determine the survival of a juvenile plant and impact adult plant performance. Understanding the factors that may impact seedling performance is thus critical, especially for annuals, opportunists or invasive plant species. Seedling performance can vary among mothers or populations in response to environmental conditions or under the influence of seed traits. However, very few studies have investigated seed traits variations and their consequences on seedling performance.

Specifically, the following questions have been addressed by this work:

- 1) How the seed traits of the invasive *Ambrosia artemisiifolia* L. vary among mothers and populations, as well as along the latitude;
- 2) How do seed traits influence seedling performance;
- 3) Is the influence on seedlings temperature dependent.

With seeds from nine Western Europe ruderal populations, seed traits that can influence seedling development were measured. The seeds were sown into growth chambers with warmer or colder temperature treatments. During seedling growth, performance-related traits were measured.

A high variability in seed traits was highlighted. Variation was determined by the mother identity and population, but not latitude. Together, the temperature, population and the identity of the mother had an effect on seedling performance. Seed traits had a relative impact on seedling performance, but this did not appear to be temperature dependent. Seedling performance exhibited a strong plastic response to the temperature, was shaped by the identity of the mother and the population, and was influenced by a number of seed traits.

Keywords: Achene variability, Competitive ability, Cotyledon area, Phenotypic plasticity, Seed colour, Seed mass

Do invasive and non-invasive plant species differ in how long their seed persist in the soil seed bank?

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Recent research indicates that among reproductive traits promoting plant invasiveness, production of seed persisting in the soil for a long time plays a role. To test the relationship between soil seed banks and invasiveness experimentally, we conducted a burial experiment to find out if there are differences in seed persistence between invasive and non-invasive alien plant species. Seed of 73 species that are alien in the Czech Republic (35 invasive and 37 non-invasive) were collected in the field, tested for viability and buried in nylon bags in the soil in a common garden at the Institute of Botany, Pruhonice. Seeds were exhumed once a year (spring 2014, 2015, 2016), and the fraction of germinated or decayed seeds, and of non-germinated but viable seeds, was determined in each sample. This allowed us to assess seed persistence/viability after 1.5, 2.5 and 3.5 years of burial in the soil.

Preliminary results after two years suggest that invasive and non-invasive species differ in seed persistence. Invasive species tend to persist longer in the soil and have thus potential to form larger and persisting for longer time seed banks than non-invasive species. Seeds of all invasive species were viable or germinated to some percentage after 1.5 year of burial in the soil, while 16% of non-invasive species did not survive during this burial period. Moreover, the majority of invasive species showed a high seed survival percentage (survival category 75-100%), while only low percentage of non-invasive species germinated or were viable after this period in this survival category. After 2.5 years of burial in the soil, the majority of invasive species showed a seed survival percentage ranging from 5-25%, while non-invasive species were distributed rather evenly among all other survival percentage categories, with only 5% species in highest survival category. The differences in seed persistence between two categories of alien plants after 3.5 years of burial will be presented and discussed.

Keywords: seed persistence, burial experiments, seed viability, invasive status

First come first served: priority effect benefits *Ambrosia artemisiifolia* L. more than other ruderal Asteraceae species

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In plant communities, species that start their development earlier can be advantaged over the other species. This advantage given by an earlier development is called the *priority effect* and can have an important impact on plant communities' composition and structure. This is particularly true in ruderal habitats where disturbances are frequent. Common ragweed (*Ambrosia artemisiifolia* L.) is an invasive plant causing a health crisis in Europe due to its allergenic pollen. This annual plant is highly affected by competition, has an opportunistic behaviour, and is often found in ruderal habitats.

The aim of this study was to evaluate the role the priority effect plays in the invasion success of common ragweed, by determining if the species is able to benefit more of the priority effect than other comparable species from ruderal habitats.

We selected eight annual species from the Asteraceae family, growing in ruderal habitats in Belgium, among which *A. artemisiifolia*. At the beginning of the experiment, seedlings of each species were individually planted in separated pots. Three weeks later, 7 other seedlings (one per species) were planted in the pots in order to have 8 seedlings from 8 different species in each pot, with one 3 weeks older than the others. After two months, all the plants were cut at ground level, the above ground biomass was measured and the number of flowering head counted.

The results showed that *A. artemisiifolia* benefited more from the priority than all the other species: its number of flowering heads was multiplied by 600 on average and its aboveground biomass by 30, when in priority. Furthermore, when in priority *A. artemisiifolia* was the species that had the biggest negative impact on the development of the 7 other species.

These results highlighted the important advantage that *A. artemisiifolia* is able to take when starting its development without competition.

Keywords: Priority effect; ragweed; reproductive performance; community

Zebra mussel beds: a perfect shelter for prey or perfect feeding ground for Ponto-Caspian gobies

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Aggregations of the Ponto-Caspian invasive zebra mussel (*Dreissena polymorpha*) constitute a suitable habitat for macroinvertebrates, considerably increasing their abundance and providing effective anti-predator protection. Thus, the overall effect of a mussel bed on particular predator species may vary from positive to negative, depending on prey density increase and predator ability to prey in a structurally complex habitat. Alien Ponto-Caspian goby fish are likely to be facilitated in their novel areas by zebra mussels, provided that they are capable of utilizing mussel beds as habitat and feeding grounds. We ran laboratory experiments to find the prey (chironomid larvae) density (from ca. 500 to 2000 individuals m⁻²) in a mussel bed that makes it a more beneficial feeding ground for the racer goby *Babka gymnotrachelus* (RG) and western tubenose goby *Proterorhinus semilunaris* (WTG) compared to sandy and stone substrata (containing the basic prey density of 500 ind. m⁻²). Moreover, we checked how food availability affects habitat selection by fish. Mussel beds became more suitable for fish than alternative mineral substrata when food abundance was at least twice higher (1000 vs. 500 ind. m⁻²), regardless of fish size and species. WTG was associated with mussel beds regardless of its size and prey density, whereas RG switched to this habitat when it became a better feeding ground than alternative substrata. Larger RG exhibited a stronger affinity for mussels than small individuals. WTG fed more efficiently from a mussel bed at high food abundances than RG. A literature review has shown that the increase in chironomid density, which in our study was sufficient to make a mussel habitat an attractive feeding ground for the gobies, is commonly observed in mussel beds in the field. Therefore, we conclude that zebra mussels may affect positively the alien goby species and are likely to facilitate their establishment in novel areas, contributing to the invasional meltdown in the Ponto-Caspian invasive community.

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Keywords: *Babka gymnotrachelus*, *Proterorhinus semilunaris*, *Dreissena polymorpha*, invasional meltdown, ecosystem engineers

Coevolutionary relationship drives population-specific responses to an invasive species

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While our understanding of the mechanisms of arrival and establishment of non-native species is improving, predicting their impacts remains a challenge. Interacting species often express specific reciprocal adaptations to co-exist, leading to dynamic coevolutionary associations that can be distorted by new partnerships that emerge as a consequence of the non-native species arrival. The coevolutionary associations often vary across species range, forming a mosaic of coevolutionary hotspots and coldspots. Hence, as populations of a species are variable, the impact of non-native species on local taxa could crucially depend on population-specific traits and adaptations of both native and non-native species. Bitterling fishes are brood parasites of unionid mussels and unionid mussels, in turn, produce larvae that parasitize fish. We used common garden experiments to measure three key elements in the bitterling-mussel association among two populations of an invasive mussel (*Anodonta woodiana*, Unionidae) and four populations of European bitterling (*Rhodeus amarus*, Cyprinidae). The impact of the invasive mussel varied between geographically distinct *R. amarus* lineages and between local populations within lineages. The capacity of parasitic larvae of the invasive mussel to exploit *R. amarus* was higher in a Danubian than in a Baltic *R. amarus* lineage and in allopatric than in sympatric *R. amarus* populations. Maladaptive oviposition by *R. amarus* into *A. woodiana* varied among populations, with significant population-specific consequences for *R. amarus* recruitment. We suggest that variation in coevolutionary states may predispose different populations to divergent responses. Given that coevolutionary relationships are ubiquitous, population-specific attributes of invasive and native populations may play a critical role in the outcome of invasion. We suggest that a conceptual framework that considers invasive populations rather than species can provide deeper insight into the impact of invasions.

Keywords: coevolutionary association, aquatic ecosystem, fish, union mussels, freshwater, population

Climate mismatch in plant invasions contributes to the existence and length of lag phases

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The ability to predict the probability of introduced species to become invasive relies on the understanding of a multitude, not mutually exclusive, mechanisms. Multi –species studies permit to examine environmental, reproductive and dispersal factors responsible for the commonly described time lag in invasive populations. Drivers of the different stages along the introduction–naturalization–invasion continuum provide insights on opportunities and limitations of correlative species distribution models.

This study investigates drivers and processes influencing the transition from naturalisation to invasiveness and the degree of climate matching responsible for the lag phenomena in introduced plant populations. We discuss the degree of climatic niche conservatism between the two invasion stages, a key assumption of species distribution models.

Generalised linear models were fitted to herbarium data of 2,818 naturalised exotic species of Australia and New Zealand to determine the existence of lag phase and length. The degree of difference between the two climatic niches, described by eight Bioclim variables, was analysed and examined in relation to the change in geographic space. The results were tested for relationships between dispersal and reproductive traits and phylogenetic data aiming to identify drivers and patterns influencing the lag phenomena and the degree of climate dissimilarity.

Our analysis of 2,818 time series shows lag phases in only 30% of the tested plant species. The transition from a lag to an expansion phase coincided with a shift (expansion) in climate niche in the majority of tested species (86%) corroborating the view that climate mismatch has significantly contributed to the existence of lags. Climate niche expansion was positively correlated with geographical movement suggesting that most lags have ended once long dispersal (or independent introduction) has placed some propagule in a different region with seemingly more suitable climate. Adaptation-mediated termination of lag phase will gain more support, should the increase in the abundance of an invader occur in the vicinity of the first introduction foci (lag region), which harbours marginal climates. This was not the case in the majority of the tested species.

We may, therefore, conclude that for most plant invaders that undergo a period of lag before population explosion, climate uncoupling is the most parsimonious model explaining such a biphasic behaviour.

Keywords: biological invasion, lag phase, climatic niche, niche conservatism, functional traits, geographic range

Behavioural changes in biological invasions: taxonomic differences and underlying mechanisms

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Behavioural changes are recognized to shape the outcome of species interactions in biological invasions. As invasive species alter their behaviour to accommodate to native species as predators, prey or competitors, native species analogously react to invaders. Mechanisms that drive these behavioural changes range from rapid genetic evolution to individual or social learning processes, the latter only recently being recognized as a rapid means for the spread of behavioural change. We performed a systematic literature review to gather studies reporting a change in behaviour in an invasion context. From 524 relevant papers we extracted 250 individual cases of behavioural changes. The species under study came from a broad range of vertebrate and invertebrate taxa. We analysed how quickly native species adapt to non-natives and vice versa, depending on taxonomy and mechanism of behavioural change. Additionally, we compiled cases where social learning was assumed or demonstrated, and characterized these with respect to taxonomy and life-history traits. These data were analysed with respect to the question which species possess social learning capabilities. We present results of this analysis with regard to the distribution of adaptation and learning across animal taxa with special emphasis on social learning. We discuss implications of these results, stressing the importance of learning to enable rapid behavioural changes in populations of native and non-native species.

Keywords: behavioural adaptations, eco-evolutionary experience, individual learning, rapid genetic evolution, social learning, systematic review, temporal dynamics

High variation in chemical defence and other traits as trigger in plant invasion of *Bunias orientalis*?

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Entering new habitats, invasive plant species are challenged by different environmental conditions compared to their home-range. Such changes in both biotic and abiotic conditions can cause alterations in resource allocation and thus physiological shifts in various plant traits. Consequently, beneficial adaptations in the quantity and quality of chemical and morphological defences as well as in growth and reproduction might play important roles as mechanisms underlying successful plant invasion. The Brassicaceae *Bunias orientalis* L. originates in Western Asia and Southeastern Europe but has expanded its range westwards within the Eurasian continent over the past decades, particularly conquering disturbed, nutrient-rich habitats. We compared the chemical and genetic variation as well as the influence of experimentally varied resource availability on growth and defence potential between native, truly invasive and not (yet) invasive, exotic populations. The composition of various chemical plant compounds and their relationships were investigated with a metabolomics approach using ultra high pressure liquid chromatography coupled with time-of-flight mass spectrometry (UHPLC-ToF-MS). We found a pronounced metabolic differentiation between groups of populations as well as a high chemical diversity within populations. This pattern was well mirrored in the genetic distance between the plant populations, analysed with a genome-wide fingerprinting technique (amplified fragment length polymorphisms, AFLP). Plants of these populations grown in a common garden under high and low nitrate-fertilisation regimes showed also differences in the acceptance by antagonists (herbivores and pathogens) unexperienced with *B. orientalis* as well as in growth and reproductive output traits. A strong population effect in all measured traits was observed, which was partly associated with the genetic background, but also indicated defence alterations due to the invasion process. Phenotypes highly variable in defence traits and morphology might therefore facilitate the success of range-expanding *B. orientalis* populations.

Keywords: *Bunias orientalis*, intracontinental range-expansion, metabolomics, chemical diversity, genetic diversity, plant-antagonist interaction, common garden experiment, nitrate allocation

Breeding system, plant-pollinator networks and pollen limitation of exotic plant species

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Most angiosperms require animal pollinators, at least to some degree, to successfully reproduce. Exotic plant species must integrate themselves into resident plant-pollinator networks and attract the services of resident pollinators. Because these species are new to these ecosystems and have not co-evolved with resident pollinators, it is expected that they will receive lower pollinator service and therefore experience higher levels of pollen limitation. However, the magnitude of pollen limitation will depend on the breeding system of the exotic plant species and its dependence on animal pollination for reproduction (e.g., highly autogamous species are not expected to show pollen limitation). Further, exotic plant species with close plant relatives might more easily integrate themselves into plant-pollinator networks and receive adequate pollination. To test these ideas, we used a pollinator exclusion experiment to investigate the dependence of our focal exotic plant species on animal pollinators, and a pollen supplementation experiment to determine the extent to which our focal exotic species are pollen limited. Further, we collected a plant-pollinator network for each exotic plant species to determine the connectedness of each plant species. We found high variation amongst our focal exotic plant species in their magnitude of pollen limitation. Much of this variation could be explained by differences in their breeding system and integration into resident plant-pollinator networks. Our results indicate that pollen limitation can be an important factor limiting the reproduction of many exotic plant species, and demonstrates the importance of considering breeding systems and networks as predictors of pollen limitation.

Keywords: Breeding system, plant-pollinator networks, pollen limitation, exotic plant species

Divergent levels of invasion across European woodlands

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Habitat invasibility is difficult to measure in the field and often distorted locally by propagule pressure and anthropogenic disturbance. In the last years, scientists have used vegetation survey data to assess the level of alien plant invasion across habitats. However, these studies had a regional scope and differed strongly in their methodological approach, especially in their habitat classification scheme. Consequently, it was difficult to extrapolate their findings to a European level. We used data from the European Vegetation Archive (n = 246,899 plots) to compare the levels of alien plant invasion across EUNIS woodland habitat types. In addition to classifying plots to a EUNIS habitat type, we assigned a status (alien, native) and origin (e.g. intra-European taxa, extra-European taxa) for every species in a country based on multiple data sources. Data were extensively filtered and only well-represented EUNIS types were included in the analysis. We calculated levels of invasion as the number of alien species (neophytes; introduced after the year of 1500) divided by the total number of species in a plot.

First results show that softwood riparian woodlands had by far the highest level of invasion (mean = 4.9%); other riparian woodlands also reached high values (> 1.3%). By comparison, coniferous woodlands tended to rank among the habitat types with the lowest levels of invasion. The most common alien species (*Impatiens parviflora*, *Robinia pseudoacacia*, *Prunus serotina*, *Quercus rubra*) had an extra-European origin and the broadest habitat niche of all alien species. Our results confirm earlier observations that woodlands with a high disturbance regime and nutrient flow are highly susceptible to alien plant invasions. Similar levels of invasion across riparian and coniferous woodlands, respectively, indicate intrinsic biotic properties that control a habitat's susceptibility to alien plant invasions.

Keywords: forests, big data, vegetation data, invasibility, level of invasion, Europe

Topic 03

Ecological impacts of biological invasions

P-37

The role of zebra mussels on bitterling oviposition

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The presence of non-native species can affect coevolved relationships. We examined effect of zebra mussel (*Dreissena polymorpha*) on reciprocal coevolutionary relationship between a fish, the European bitterling (*Rhodeus amarus*), and freshwater mussels (Unionidae) from two populations with different coevolutionary status (evolutionary sympatry for several generations/evolutionary naïveté). In a series of experiments under experimental, semi-natural and natural conditions, we examined two main questions: a) the effect of zebra mussel on oviposition decisions and pre-oviposition behaviour of male and female bitterling from two populations with a different level of sympatry; b) the effect of zebra mussel on reproductive success of the bitterling. We found that presence of zebra mussel near unionid siphons decreased oviposition rate into the unionids in the wild and in mesocosm. There was no effect of bitterling-zebra mussel sympatry in samples from the wild, but we found stronger decrease in bitterling use of the unionid mussels with increasing intensity of zebra mussel fouling in the mesocosm. Females oviposited less into infected unionid mussels, but did not avoid them completely. Interestingly, female bitterling sometimes oviposited directly into the zebra mussel, with a consequent failure of the eggs to develop. Behaviourally, females inspected infected mussels at the same rate as non-infected mussels, so their decision to avoid infected unionids was active.

Keywords: aquatic ecosystem, zebra mussel, fish, unionids, coevolution, host-parasite relationship, oviposition, reproductive success

Humans help non-native plants break rules of species coexistence

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Biological invasions are considered among the chief threats to biodiversity, but whether invading species cause the loss of species from their own trophic level is hotly contested. Here we use theoretical and empirical evidence to counter the calls to end invasion ecology by showing how non-native plant invasions can disrupt mechanisms of species coexistence, leading to native plant extinctions.

By planting and dispersing non-native species in high numbers, humans can effectively increase the colonization ability of some species in a way that is independent of their ecophysiological traits. Transporting species beyond historical ranges can release species from their enemies, reducing their mortality or enabling them to reallocate resources from defense into competitive ability or reproduction. If species coexistence relies on tradeoffs among the colonization and competitive abilities of species, human-assisted alien invasions should lead to eventual declines in species diversity and coexistence.

Using simulation models, we show that species invasions, alone and with elevated disturbance, can alter community diversity in different ways and at different points in time. Short-term increases in local (alpha) diversity soon after invasion can belie long-term reductions in alpha diversity. Regional (gamma) diversity takes longer to respond to invasion, but generally declines following invasion. Impacts on community diversity are affected by the characteristics of the invaders and how they compare with characteristics of the native species. Invaders that are more competitive have greater impacts on diversity, but their impacts vary depending on whether invasion coincides with disturbance or not. Some invaders can increase alpha diversity yet still cause a decline in gamma diversity. We support our theoretical work using empirical evidence from the literature and from a six-year seed addition experiment in Minnesotan prairie.

Keywords: niche theory; extinction debt; alien plant species; ecological impact; biodiversity loss; species richness; invasion impacts; invasive species; competition-colonization tradeoffs

Global patterns in extinction and threats to vertebrates by biological invasions in islands

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Alien species have a range of impacts documented in their new environments, and there are well-documented examples of native species that have been driven extinct by aliens. However, biological invasions as drivers of biodiversity loss have recently been challenged. Some of the arguments about the impacts of alien species have been based on data on extinction, and extinction risk from the IUCN Red List. This is a dynamic resource, for which regular updates add ever greater and more accurate information on the conservation status of increasing numbers of species. Here, we revisit this resource to assess the current state of knowledge about biological invasions on islands.

We report links between vertebrates threatened by more than 200 invasive alien species from the completely revised Global Invasive Species Database. Our results show that invasive alien species are the second most common threat associated with species that have gone extinct from these taxa since AD 1500, especially on islands (>85%). New maps of the vulnerability of threatened vertebrates show that centres of IAS-threatened vertebrates are concentrated in the Americas, India, Indonesia, Australia and New Zealand, especially on islands. We found that the threat posed by invasive alien species in relation to other threats (i.e, habitat loss, pollution, overexploitation, climate change) is greater on islands than mainland areas, except in South America. Overall, there tend to be fewer threats on islands than on mainland areas. The differences in invasive threats between regions and taxa can help efficiently target invasive alien species, which is essential for achieving the Strategic Plan 2020 of the Convention on Biological Diversity. Fundamentally, we must know where species that are threatened by invasive alien species live, and the degree to which they are threatened.

Keywords: Biological invasions, IUCN Classification, islands, spatial analyses, vertebrates

Competition for host resources between invasive (*Anodonta woodiana*) and native freshwater mussels

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Effects of invasive alien species on host-parasite relationships are often subtle and remain unnoticed or insufficiently quantified. We investigated *Anodonta (Sinanodonta) woodiana*, a species of unionid bivalves with complex life cycle, which include obligatory parasitic stage (glochidium) developing on fishes. The geographic range extensions expose *A. woodiana* to novel communities of native fish hosts and their affiliate bivalves. It is expected that *A. woodiana* compete with native unionids for hosts, but no direct evidence or quantification of this process was available. Several potential mechanisms of the competition for hosts can be expected such as direct competition by glochidia for space on hosts or via the activation of innate host tissue responses. Most importantly, the glochidia of invasive species may trigger an adaptive immune response by hosts, making them immunized against repeated infections after contact with glochidia. Our study focuses on the role of priming infections by invasive glochidia on the parasitism success of native mussel species. We experimentally tested the capacity of European *A. anatina* to parasitize *Squalius cephalus* after previous infections with *A. woodiana*. We compared the dynamics of initial glochidia attachment, the length of the parasitic period and the transformation success rate of *A. anatina* glochidia among treatments. Our results document a strong cross-resistance between the invasive and native species as the transformation success rate of *A. anatina* was significantly reduced on primed hosts in comparison to naïve. Such cross-resistance is expected to significantly decrease the quality of host resources available to native mussels in natural habitats. The results provide novel insights on the competitive mechanisms between unionid bivalves and describe novel process affecting the invasion potential of invasive affiliate species such as *A. woodiana*.

Study was supported by the Czech Science Foundation (13-05872S).

Keywords: Sinanodonta, host-parasite relationships, Unionidae, glochidium, cross-resistance, host competition

Prioritisation of alien plant species list for invasive plant monitoring in Latvia

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Invasive alien plant species cause important ecological and economic losses in Latvia, as they do worldwide. Effective management of alien plant species requires their appropriate grouping and prioritisation in national scale. Current official list of invasive organisms in Latvia includes only *Heracleum sosnowskii* Manden. (Cabinet regulation No. 468. List of invasive alien plant species). However, actual list of alien plant species in Latvia consists more than 500 taxa (Svilāns et al. 2007) with very different level of invasiveness – casual alien plants, arboreal trees with episodic escaping from cultivation, local invasions only in botanical gardens e.o. From the list of alien species of Latvia, a group of invasive plant species was selected. The highest priority is given to species that satisfy the criteria, described in European and Mediterranean Plant Protection Organization (EPPO) methodology of prioritization process for invasive alien plants (Anonymous 2012) as well as supplemented with some specialised criteria, selected for local conditions and requirements of invasive plant monitoring: 1) negative impact on EU habitats, 2) data not obtained in other monitoring programmes in Latvia, 3) plant reproduces effectively in wild nature, 4) massive weed of agriculture, 5) genetical erosion of any native species, 6) invasive species in neighbouring countries, 7) species assesment has been carried out in Latvia (actual number of localities e.o), 8) widely cultivated plant species, 9) invasion not subsided for concrete species.

Based on criteria adopted, 35 invasive plant species, appropriate for invasive plant monitoring was identified. – *Acer negundo* L., *Amelanchier spicata* (Lam.) K. Koch., *Aster salignus* Willd., *Cotoneaster lucidus* Schldl., *Echinocystis lobata* (Michx.) Torr. et A. Gray, *Impatiens glandulifera* Royle, *Impatiens parviflora* DC, *Lupinus polyphyllos* Lindl., *Rosa rugosa* Thunb., *Sambucus racemosa* L., *Solidago canadensis* L., *Solidago gigantea* Aiton, *Sorbaria sorbifolia* (L.) A. Braun, *Reynoutria japonica* Houtt. and *Reynoutria sachalinensis* (F. Schmidt) Nakai shows doubtless invasiveness in national scale, to agree with at least seven above mentioned criteria and were decided as priority group for invasive plant monitoring.

References

- Anonymous (2012). EPPO prioritization process for invasive alien plants. Bulletin OEPP/Bulletin, 42 (3): 463-474.
- Svilāns A., Celmiņš A., Āboliņa A., Teļnovs D., Vimba E., Gavrilova Ģ., Strāķe S., Pilāts V. (2007) List of alien species in Latvia. biodiv.daba.gov.lv/cooperation/invaz/iv-netam_ivazivie.xls

Keywords: Invasive plants, monitoring, prioritisation, Latvia

***Impatiens parviflora* affects native vegetation in oak-hornbeam forests**

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Impatiens parviflora is one of the most widespread invasive plant species in Central Europe. Nevertheless, the mechanisms of its invasion are still poorly understood. In this study we attempt to understand the impact of this species on native vegetation.

The impact of *Impatiens* on native vegetation was studied using removal experiment on permanent plots in oak-hornbeam forests in central Bohemia, Czech Republic. Ten pairs of plots were established in invaded vegetation, one plot in each pair stayed invaded and the other served as removal plot and all *Impatiens* individuals were repeatedly removed from the plot. Species composition in 4 subsequent years was recorded in the plots. Species response to *Impatiens* removal was correlated to plant traits to reveal trait characteristics of species suppressed or supported by the invasion.

Significant increase in both numbers and cover of native species was observed in removal plots in comparison with control plots during the experiment, with the greatest change in first two years after invader removal. Species composition also significantly differed between control and removal plots. Species with high affinity to removal plots, i.e. species that are most restricted by *Impatiens* invasion, were mostly species with small releasing height and early start of flowering.

Our results indicate that *Impatiens parviflora* has negative impact on native vegetation but that the vegetation can recover within few years after the invader removal. Due to its extensive distribution and high turnover, removal of the species from larger plots is, however, not realistic in practice.

Keywords: *Impatiens parviflora*, small balsam, impact, removal experiment

How the burrowing activity of the North American crayfish *Procambarus clarkii* alters the seepage process in river levees

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The North American crayfish *Procambarus clarkii* is an invasive species mostly introduced for commercial purposes. It causes declines in biodiversity and radical habitat change while showing a high dispersal probability and reproduction rate enabling it to rapidly spread within the invaded areas. Several scientific efforts studied the effects (e.g. increased turbidity, vegetation loss, food web structure disruption) this species has on recipient ecosystems. Only recently, scientific focus was given to damages caused by *P. clarkii* on levees of rice fields, irrigation ditches and small rivers. Indeed, burrowing activity can enhance the seepage process, affecting the integrity of the structure.

In order to understand the impact of burrowing activity on the seepage process, since 2015 we have conducted experiments in artificial environments at the Hydraulic Laboratory of the Department of Civil and Environmental Engineering of the University of Florence, using a small-scale model of a levee built inside a tank. The model was mostly composed by silt, clay and sand (the favoured soil for the burrowing activity of the species) and equipped with microtensiometer to measure the phreatic line within the levee. A series of several experiments was carried out, and for each replicate, water level was kept constant on a side (riverside) of the levee and the other side was initially left dry (landside). Two couples of crayfish (composed of one adult male and one adult female), were transferred into the wetted side to observe their burrowing activity for four days under natural light-dark cycles. The animals were fed daily to limit the probability of aggression and cannibalism among specimens. Animals were removed from the tank at the end of all experiments and burrows were filled with polyurethane foam. After one day, the mold of consolidated foam was removed from the levee to measure the volume and analyse the shape of the burrows.

In general, animals started digging immediately after their insertion, particularly in the summer, altering the water clarity and increasing the suspended solids. Burrows resulted to be irregular, composed by more than one tunnel and sometimes with a chamber at the end. The ratio of the excavated volume to the initial volume of the physical model ranged from 1 to 18% among the experiments. The presence of burrows in the levee favours the raise of the phreatic line, increasing the possibility of its emergence on the landside, and potentially affecting the integrity of the structure.

Keywords: invasive species, impact, burrowing

Effect of an alien fish, the racer goby (*Babka gymnotrachelus*), on the occurrence of the European bullhead (*Cottus gobio*)

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Racer goby is a fish of Ponto-Caspian origin, currently spreading in Europe. It has been supposed to cause harmful effects on native bullhead populations. We conducted laboratory and field studies to assess the mechanisms of competitive interactions between the species assuming that competitive resources are shelters and food. To check the outcome of the competition for a shelter, we measured behavioural interactions between 2 specimens (one- or mixed-species treatments) in a tank with 1 shelter (PVC half-tube), with the following factors included: fish size (2 size classes), light (day, night), season (spring, autumn), water flow velocity (0, 10 and 30 cm s⁻¹). To check the result of competition for food, we tested fish using the same design, but with a feeder instead of a shelter as a limited resource and including only one factor: light (day, night). We analysed the following variables: aggressive interactions (attacks, threatening acts), time spent by the fish in a shelter/feeder area, feeding time, frequency of visits and the species identity of the first visitor in the shelter/feeder in each interspecific pair. In the field, we assessed niche overlap and relationships of specimen counts among 4 fish groups (2 species x 2 size classes) on various bottom substrata across the entire width of the river bed in a tributary of the Vistula River. We found that the racer goby is more aggressive than European bullhead of similar size. That is why the gobies displace bullheads from shelters and feeding grounds. Competition for a shelter is more intensive during spawning season (spring) when both species use similar habitats for spawning and parental care of eggs. This could have harmful consequences for bullhead populations. Moreover, the racer goby has appeared as a highly adaptive competitor, being able to win the competition for shelters even when exposed to water flow velocity of 30 cm s⁻¹. This means that in rivers colonized by the racer goby, European bullheads are likely to be limited to areas avoided by the alien species, such as fast flowing river stretches with stony bottom.

The research was supported by a Grant of the Polish Ministry of Science and Higher Education No. N N304 371539.

Keywords: Ponto-Caspian gobiids, Interspecific competition, Alien species impact, Aggressive behaviour

CIMPAL: Mapping the cumulative impact of alien species on marine ecosystemsStelios Katsanevakis¹, Heliana Teixeira², Fernando Tempera², Evangelos Boltsis¹¹*University of the Aegean, Department of Marine Sciences, Mytilene, Greece*²*Joint Research Centre, Institute for Environment and Sustainability, Water Resources Unit, Ispra, Italy*

CIMPAL (Cumulative IMPacts of invasive ALien species) is a standardized, quantitative method developed to assess and map cumulative impacts of invasive alien species on marine ecosystems. According to this model, cumulative impact scores are estimated on the basis of the distributions of invasive species and ecosystems, and both the reported magnitude of ecological impacts and the strength of such evidence. We applied CIMPAL in two case studies: (1) in the entire Mediterranean Sea, using presence/absence data for the distribution of species and habitats in 10x10 km cells, and (2) in the marine NATURA-2000 sites of Greece, using detailed habitat maps and presence data of alien species. In both cases, data on the presence/absence of invasive marine alien species were retrieved from the European Alien Species Information Network (EASIN). In the Mediterranean case study, the CIMPAL index showed strong spatial heterogeneity and spatial patterns greatly varied depending on the pathway of initial introduction of the invasive species. In the Greek case study, the spatial patterns of impact were analyzed by Generalized Additive Models of the CIMPAL index in relation to the area of each site, its longitude and latitude. The CIMPAL index increased due to the increased richness of both alien species and habitats with area. The index increased with latitude in accordance to the higher alien species richness at higher latitudes, when considering only benthic habitats. No significant pattern in relation to longitude was revealed. In both cases, the analyses allowed the identification of hotspots of highly impacted areas, and prioritization of sites, pathways, and species for management actions. The application of the CIMPAL index in both cases provided a baseline that can be built upon with future improved information (such as estimates of the alien species abundance at each site instead of presence/absence data). Such analysis and mapping of impacts is urgently requested by policy makers and managers, e.g. for the implementation of the EU Marine Strategy Framework Directive.

Keywords: cumulative impacts, indicators, prioritization, Mediterranean, Greece

The competition between invasive and native plants for pollinators

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Invasive plant species are making changes not only in plant communities during penetrating in new areas. They are also capable to change the composition of pollinators' communities of native plants by attracting anthophilous insects because of more resources nectar and pollen. In this case, native flora plants may suffer from a pollen limitation and even be not enough pollination. Thus, invasive species can create competitive pressure on native species for pollinators.

We studied the effects of invasive hogweed *Heracleum sosnovskyi* Manden to the composition of the pollinators' communities of native plants of the same family Apiaceae in Belarus. As such, we have chosen the species that grow in similar areas: goutweed *Aegopodium podagraria* L, wild carrot *Daucus carota* L, beaked parsley *Anthriscus sylvestris* (L.) Hoffm. and angelica officinalis *Angelica archangelica* L. We defined the taxonomic structure of these pollinators communities of umbrella plants. Then we estimated the intensity of the competition for pollinators between plants using Shener index of overlapping of the spectra. The results showed that the highest similarity of taxonomic structure of pollinators' communities observed in pair cow parsnip Sosnowski and wild carrot (0.622). Also high index indicators were typical for pairs Sosnovsky hogweed and goutweed (0.581) and Sosnovsky hogweed and beaked parsley (0.516). Namely these plants species under joint growing are most likely remain with lack of pollen. This is primarily due to pollen limitation which can lose during process of transferring by pollinators to flowers of another plant species. *Heracleum sosnowskyi* as large plant with big inflorescences is the source of a large amount of nectar and pollen and it more successful attracts insect pollinators than others umbellifers.

Thus, the overlapping of the spectra of taxonomic structure of pollinators communities indicates the interspecific competition, sometimes very strong. As a result, native plants are at risk of extinction or enhancement of directional selection pressure to restrict certain groups of pollinators or they need to change the time of flowering to avoid competition with more potent invasive species.

Keywords: insect pollinators, *Heracleum sosnovskyi*, competition for pollinators

Genetic diversity of *Impatiens parviflora* DC. populations in relation to abiotic and biotic environment

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Impatiens parviflora has emerged in Europe in the early 1800s and areas occupied by this species are still increasing. Within former century wide studies have been performed concerning phytosociology and physiology of *I. parviflora* growing in Central and Western Europe. In a contrast to the other widely spread aliens, like *Heracleum* spp., *Fallopia* spp. or *Impatiens glandulifera*, *Impatiens parviflora* was already forgotten, when molecular investigation of invaders started and till now remains among the least genetically examined aliens. Data concerning routes and consequences of the spread of this species in more Eastern and Northern parts of the continent are extremely poor.

Present study is aimed at evaluation of molecular diversity of *I. parviflora* populations growing in Eastern Baltic with special stress for relations between genetic diversity and abiotic and biotic environment. Twenty-one populations of *I. parviflora* were selected in the way to cover all the territory of Lithuania. When selecting populations for sampling, attention was paid to reflect habitat diversity, including both urban and semi-natural sites. Dominant DNA markers were chosen for examination of populations applying Bayesian Structure analysis. In addition, associated species, their projection coverage were recorded and Ellenberg indicatory values (EIV) were calculated. For each site several environment features were recorded and populations were grouped according to each parameter into 2-4 clusters: water source and its proximity; traffic intensity / road vicinity, proximity to human buildings. Nei's genetic distances among populations differed up to 4 times. Molecular diversity among populations was much higher than intrapopulation diversity. The Bayesian analysis of over 300 individuals of *I. parviflora* revealed, that a simulation equilibrium (likelihood of K's) provided by the genomic structure for the model was reached at K = 13 (in case of Randomly amplified polymorphic DNA markers) and K = 11 (in case of inter-simple sequence repeat markers of DNA). The most frequent neighbors' of *I. parviflora* were following species: *Urtica dioica*, *Aegopodium podagraria*, *Chelidonium majus*, *Galium aparine*, *Anthriscus sylvestris*, *Alliaria petiolata*, *Heracleum sibiricum*, *Geum urbanum*, *Impatiens noli-tangere*. EIV of neighboring species showed prevalence of neutral and rich in nitrogen soils. Interrelations between population genetic parameters and their environment features will be discussed.

Study was funded by Lithuania Science Council, Project No. LEK-07/2012; SIT-02/2015

Keywords: alien plants, invasive species, Ellenberg indicatory values, Balsaminaceae, small balsam, molecular variance, dominant markers, ISSR, RAPD

***Acacia dealbata* impacts in Mediterranean areas worldwide: phylogenetic loss in novel plant communities' assemblages.**

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The Australian tree *Acacia dealbata* Link (Mimosaceae - Fabaceae) is one of major invaders in the Mediterranean ecosystems of Europe, Africa and America, where it forms dense monospecific patches severely affecting native plant communities. The effects of this species on the native biodiversity are well-known and are linked to a reduction in species richness and diversity, which generates poorer and less-diverse novel communities compared to native ones. To this regard, the effect of this species on the phylogenetic structure of invaded communities are poorly known and investigated.

The present study evaluates the impacts of *A. dealbata* on phylogenetic diversity of invaded communities and the phylogenetic structure of these novel plant communities after the invasion by *A. dealbata*. Toward these aims we exploited data from samplings conducted in Mediterranean scrublands located in the limit of the Mediterranean area (Northwest of Spain), in the middle of the bioclimatic region in Europe (Elba Island), and in Mediterranean climate areas from Chile. Three levels of invasion statuses were differentiated according to the gradient generated by *A. dealbata* during the invasion process (invaded, transitional and non-invaded sites) in each studied community. We firstly studied the variation in taxa richness and diversity. Subsequently, we built a phylogenetic tree adopting the AGPIII phylogenetic information. Finally, we studied and compared the variation in phylogenetic distance (PD) and mean phylogenetic distance (MPD) among different invaded statuses and biogeographic areas. Data analyses confirm that invasion by *A. dealbata* generally causes a strong decrease in the richness and diversity of understory plant species following the ranking invaded > transitional > non-invaded sites, with effects comparable in the three invaded ranges. The phylogenetic data suggest that the loss in native species is linked to a severe phylogenetic loss in the invaded communities. Indeed, PD was also found to strongly decrease following the above-mentioned trend. On the other hand, MPD showed still the lowest values in invaded sites, but with more variation among biogeographic areas for the relationship between transitional and non-invaded sites.

Keywords: Phylogenetic distance, Mean Phylogenetic Distance, species richness, Phylogenetic Diversity

Freshwater crayfish invasions in South Africa

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No indigenous freshwater crayfish species exist in continental Africa, but several North American and Australian species have been introduced since the 1970s. In South Africa, four species of alien crayfish are listed under the National List of Invasive Freshwater Invertebrate Species: the Danube crayfish (*Astacus leptodactylus*), the common yabby (*Cherax destructor*), the marron (*Cherax tenuimanus*) and the Australian redclaw crayfish (*Cherax quadricarinatus*). It is known that *Cherax quadricarinatus* was introduced into South Africa via Swaziland around 2000, after escaping from the Sand River Dam, where it was farmed, due to a large flooding event. However, no detailed information exists on the distribution, abundance and impacts of populations of this or other potential crayfish species in South Africa.

In this study, we start by presenting an overall view of the current knowledge of crayfish invasions in South Africa. Then, we focus on the Australian redclaw crayfish (*C. quadricarinatus*), the only species that appears to be widely distributed in the country. For this, we performed sampling surveys in several regions in South Africa and Swaziland, in which collapsible baited crayfish traps were set along water bodies, left overnight, and checked the following morning for crayfish presence. All the individuals were sexed, weighed and measured. We report on the presence of established populations of *C. quadricarinatus* in rivers and irrigation dams in Mpumalanga and several areas in Swaziland. We also look at crayfish abundances, biomass and sex ratio.

We discuss the implications of these results regarding the potential presence of additional crayfish populations in South Africa, and the possible impact of *C. quadricarinatus* on native biota and natural habitats. This information is essential to support the development and implementation of adequate action plans for the management and control of invasive crayfish species in South Africa.

Keywords: crayfish, Africa, status, populations

Feral cat (*Felis silvestris catus*) predation at a biodiversity hotspot scale: the case of the New Caledonian Archipelago

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Biological invasions are one of the main threats to biodiversity, especially on islands where introduced species are the first cause of biodiversity loss. Alien mammalian predators are responsible for numerous island species extinctions worldwide, and feral cats (*Felis silvestris catus*) are among the most successful and damaging invaders due to their generalist predatory behaviour and their high reproductive and survival successes. Although a strong feral cat impact was suspected on the New Caledonian archipelago (south Pacific), no previous study and cat predatory evaluation had been conducted.



This study aims to evaluate feral cat impact on this biodiversity hotspot that shows exceptional endemic rates, partly due to its geographical isolation and specific ultramaphic soils. Feral cat invaded almost all the islands of this archipelago from seashore habitats to highest altitude forest (1628m), most of these habitats harbouring unique species assemblages. In order to study cat predation, we calculated, through scat analysis, its predatory consumption of every taxonomic prey group with a focus on endemic species. We collected, and then macroscopically analysed, more than 6000 cat scats found upon 16 sites representing the different habitats of this archipelago. This sampling was conducted across 4 to 6 sampling sessions per site over 2 years. At the archipelago's scale, cats mainly prey upon introduced rats (Frequency of Occurrence (FO): 77%). This staple resource could boost cat population dynamics and subsequently cat impact on native preys. In addition, cats strongly prey upon reptiles (FO: 42%), flying foxes (FO: up to 30% in some humid forests), most of them being endemic, and petrels (FO: up to 25% in some mountain areas). Feral cats at least prey upon 17 threatened species corresponding 4 species listed by the IUCN Red List as "critically", 7 endangered and 6 vulnerable. This species list includes 3 flying foxes, 2 birds, 1 gecko and 11 skinks, most of them being exclusively present inside the mosaic maquis/humid forest habitat that covers a major part of the main island. This study also confirms the strong variations in cat diet according to habitats and highlights original cat predation patterns on alien and endemic species. This study provides recommendations to prioritize management and conservation strategies in a biogeographic region where such actions are urgently needed to preserve island biodiversity and ecosystems.

Keywords: *Felis silvestris catus*, invasive predator, trophic behaviour, diet, threatened species, islands

Friend or enemy? Chemical recognition and reciprocal responses among native and alien amphipods

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In aquatic environment, intra- and inter specific communication is often associated with infochemicals used e.g. in reproductive behaviour, early-warning systems for predator detection, identification of predation pressure or food detection. The ability to respond adequately to environmental cues is crucial for invasive species, facing new communities with unknown predators, prey and competitors. On the other hand, they can also encounter other aliens from the same native region, and the capability of recognizing them is likely to increase their fitness in new locations. In our experiments we focused on amphipods, which are considered as a perfect model for ecological and behavioural studies, due to their high environmental impact and gregariousness. We studied intra- and interspecific recognition of chemical stimuli released by three invasive freshwater gammarids originating from Ponto-Caspian region (*Dikerogammarus villosus*, *Dikerogammarus haemobaphes* and *Pontogammarus robustoides*) and indigenous European *Gammarus fossarum*. The ability of chemical recognition among these species was checked in all pairwise combinations.

We conducted our experiments in a y-maze tank with gravitational inflow of water (0.5 L min⁻¹) to the y-arms from two separate source tanks with appropriate signals (scent of living animals or their alarm cues) or control water. Scent of living animals was obtained as the water from a 200-l tank with 300-400 individuals incubated for at least 24 h. Alarm cues were obtained by manual crushing of c.a. 10 gammarids and adding their exudate to the source tank. We analysed three variables: time spent in a given y-arm, number of entrances to the arms and activity of animals.

All the tested amphipod species responded to the applied signals. Only *D. villosus* was attracted to the alarm cues and living heterospecifics, but not to living conspecifics. *P. robustoides*, *D. haemobaphes* and naive *G. fossarum* avoided the scent of the strongest competitor and predator, *D. villosus*, and/or decreased their activity in its presence. Interestingly, the presence of *D. haemobaphes* reduced activity of the other species.

Our results showed that the behaviour of *D. villosus* was distinctly different from the other species, as it was attracted to most of the applied scents. This confirms its status of a very strong competitor and predator, which interprets various scents as food cues and is perceived as a threat by other gammarids.

The study was supported by National Science Centre grants 2011/03/D/NZ8/03012 and 2012/05/B/NZ8/00479.

Keywords: amphipoda, Ponto-Caspian species, communication, alarm cue

Species invasions as perturbations to mutualistic interactions: complementary theory and empirical work

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When species invade outside their native ranges, they will usually interact with new species and form novel communities. Because they are integrating into existing networks of interactions, invasive species can act as perturbations to a resident community.

We use complementary theoretical and empirical approaches to generate and test predictions about how invaders impact plant-pollinator communities.

First, we demonstrate experimentally that the invasion of an invasive thistle (*Carduus acanthoides*) can significantly increase the species richness and abundance of a wild bee community.

Then we apply network theoretic models to the empirical community affected by invasive Himalayan Balsam (*Impatiens glandulifera*) to generate theoretical predictions about how multiple aspects of mutualistic network structure will change in response to the addition of a novel species.

The predictions suggest that the impact of the perturbation on network structure increases with the generality of the invader. This theoretical-empirical approach can be used to anticipate the impact of species that are currently changing in distribution and provides testable hypotheses for how invasive species will change resident networks of interactions.

Keywords: mutualism, network theory, invasive species, plant-pollinator, bees, *Carduus acanthoides*, *Impatiens glandulifera*

Potentially invasive birds in Ukraine

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During the last decades, rare cases of observation of non-common species of birds became known on territory of Ukraine. The numerous cases, related to the parrots (Psittaciformes), Estrildid finches (Estrildidae), are known for today, which often escape from captivity, however form some local populations in spite of cool climate for them. However, there is another group of species that feels themselves comfortably in the climatic terms of Ukraine, but geographically related to North and South America, and also with Australia and different regions of Asia. Such species as Muscovy duck (*Cairina moschata*), Mandarin duck (*Aix galericulata*), Wood duck or Carolina duck (*Aix sponsa*), Black swan (*Cygnus atratus*), Snow goose (*Chen caerulescens*), Bar-headed goose (*Anser indicus*), Canada goose (*Branta canadensis*), Chiloé wigeon or Southern wigeon (*Anas sibilatrix*) and some other often escape from private and public zoos. Three last species are able to fly to Ukraine from established in Western Europe populations. Most of them feel themselves comfortably on this territory (even in cities), and at formation of viable populations these birds can directly or/and indirectly influence on local ecosystems, make an impact on vegetable cover (including agricultural one), conduct hybridization with local species, and also forcing out local species of their common habitats. Except it, these species can be a potential danger for aviation flights and dangerous for domestic animals and human health. Therefore, it is necessary to conduct the regular monitoring of reservoirs and other natural habitats in order to reduce such potential invasive dangerous bird species in time, work out steps and plan management activities for control their numbers.

Keywords: invasions, Ukraine

Diet composition and trophic interactions between round goby and native benthophagous fish in the coastal waters of SE Baltic Sea

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The round goby (*Neogobius melanostomus*) is a very successful invasive fish species, which was unintentionally introduced to the Baltic Sea in 1990 and since then became a key component of benthic ichthyofauna in invaded areas. As aggressive opportunistic predator, round goby easily adapts to feed on various different preys and usually outcompetes native fish in the food competition.

To evaluate potential negative effect of round goby to native benthivorous fish, feeding patterns, including diet composition, feeding activity and feeding niche overlap of differently sized round gobies, flounders (*Platichthys flesus*) and vimbas (*Vimba vimba*) were determined. Sampling took place in the SE Baltic Sea, Lithuanian coastal waters during July-September 2015 using multi mesh (14-60 mm) gill nets. Dietary analysis was performed in 147 round gobies, 205 flounders and 72 vimbas.

The smallest specimens of round goby (60-120 mm) and flounder (100-120 mm) preyed mainly on polychaetes, while larger individuals of both species preferred bivalve mollusks *Macoma balthica*, *Mya arenaria* and *Cerastoderma lamarcki*. The diet of vimba was composed of equal proportions of bivalves, brown shrimps *Crangon crangon*, polychaetes and macroalgae. Round goby fed more actively than vimba, but its feeding activity was lower compared to flounder. Round goby was the most efficient benthic feeder (19.7% of non-feeding individuals) followed by flounder (37.1%) and vimba (44.4%). Feeding niche overlap between differently sized round gobies, flounders and vimbas was biologically significant, indicating high rates of food competition among native and invasive bottom dwelling fish. Invasion of the round goby did not pose detrimental effect to prey populations, because biomass of soft bottom zoobenthos did not decrease after the round goby introduction.

Keywords: round goby, benthophagous fish, food competition

Size matters: predation of fish eggs and larvae by native and invasive amphipods

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Invasive predators can have dramatic impacts on invaded communities, especially in fresh waters. Invasion by the killer shrimp *Dikerogammarus villosus* is often followed by extreme declines in resident macroinvertebrate populations, thought to be driven by predation. Since *D. villosus* has been observed to consume fish eggs and larvae, there are concerns over similar impacts on fish populations – but these remain poorly quantified.

In laboratory microcosms, we compared the predatory impact of invasive *D. villosus* and a native analogue *Gammarus pulex* on the eggs and larvae of two representative fish species: ghost carp (*Cyprinus* sp.) and brown trout (*Salmo trutta*). We used size-matched amphipods as well as larger *D. villosus* to reflect natural sizes. We quantified predation of fish eggs or larvae presented (a) at a range of densities (to quantify functional responses) and (b) at fixed densities in the presence of alternative foods (allowing assessment of electivity).

Carp eggs and larvae were readily killed and consumed by all amphipod groups. Large *D. villosus* had functional responses 1.6 to 2.0 times higher than the smaller amphipods, whose maximum feeding rates did not differ. In electivity experiments involving carp eggs, large *D. villosus* consumed more food overall and more eggs than the smaller amphipods. Intermediate *D. villosus* also consumed more eggs than *G. pulex*. In electivity experiments with carp larvae, consumption did not differ between amphipod groups.

Large *D. villosus* were much more likely to prey upon trout larvae (74% of individuals) than intermediate *D. villosus* (29%), in turn more likely to kill trout larvae than *G. pulex* (6%). However, these predators rarely killed more than one larva. Trout eggs were almost completely invulnerable to amphipod predation: only 2% of amphipods killed any eggs.

In sum, our data suggest *D. villosus* will have a greater predatory impact on fish populations than *G. pulex*, primarily due to its larger size. *D. villosus* could have a *per capita* impact on coarse fish around 1.6 times that of *G. pulex*, and an unprecedented *per capita* impact on salmonid larvae. Even a small increase in predatory pressure following *D. villosus* invasion could negatively affect recruitment into biologically or commercially important fish populations (Houde 2002).

Reference

Houde, E.D. (2002) Mortality. In Fuiman, L.A. & Werner, R.G. (eds) *Fishery Science: The Unique Contributions of Early Life Stages*, pp 64–87. Blackwell Science.

Keywords: *Dikerogammarus*, predatory functional response, invasive species, impact, body size

Impact assessment of alien plant species in forest ecosystems of Poland - methodological and practical remarks

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The need for the unification of evaluation criteria for invasive species, or alien species in general, has been reported for a long time. A publication by Blackburn and co-authors (2014) became a new impulse to further testing and discussion.

The methodological concept was tested on the group of 176 alien plant species recorded as permanently established in forest ecosystems of Poland. Every species was subjected to an evaluation according to the criteria determined by Blackburn et al. (2014). The following scope of data collected for the species examined constituted the basis of the assessment: the most frequent pathway of introduction; the number of localities; dynamic tendencies; the degree of participation in plant communities; impact; hampering of forest management.

From the alien plant species identified from the forests of Poland, the taxa penetrating the best preserved forest communities deserve the greatest attention - over 20 species from the total analysed were ranked in this group. Considering forest management, an important group of species are those which can hamper forest restocking. About 30 (over 17%) of the alien species occurring in forests of Poland belong to this group. One third of them require the implementation of special treatments before undertaking work associated with planting trees, which causes measurable losses in forest management.

In determining the kind and the level of impact of species on ecosystems the greatest problem constitutes the lack of accurate data obtained as the result of long-term studies. This lack has resulted in the identification of direct competition as being a primary impact for most of the species investigated. Only a few species were identified as having an influence through hybridization, toxicity, bio-fouling or chemical impacts on ecosystems. The lack of long-term studies in relation to the reaction of ecosystems to the presence of alien species also constituted a problem in determining the general impact category. Therefore, as many as one third of all analysed species were placed in a "Data Deficient" category. Moreover, in the case of the highest impact categories "Major" and "Massive", determining the reversibility of changes in the ecosystem caused by alien species was a problem, and therefore only in a few cases was it possible to rank the species in the highest category.

Blackburn TM et al (2014). A Unified Classification of Alien Species Based on the Magnitude of their Environmental Impacts. *PLoS Biology* 12(5): e1001850.
doi:10.1371/journal.pbio.1001850.

Keywords: environmental impact, prioritization, invasive alien species, non-native species

The content and constituents of the essential oil in alien and native species of *Solidago* L.

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Invasive species of *Solidago* for Europe – *S. gigantea* Ait. (9 specimens); *S. canadensis* L. (9 specimens), *S. rupestris* Raf. (2 specimens) and *S. graminifolia* (L.) Salisb. (= *Euthamia graminifolia* (L.) Nutt.) – were studied along with the native *S. virgaurea* L. (2 specimens). Comparison of yield and component composition of the essential oil in leaves and inflorescences of plants in different phenophases was carried out.

In indigenous *S. virgaurea* leaves and inflorescences contain trace amounts of essential oil (0.03-0.05%). In alien invasive species amount of essential oil in these organs increase in line *S. gigantea* (up to 0,16%) → *S. rupestris* (up to 0,22%) → *S. canadensis* (up to 0,44%) → *S. graminifolia* (0.55%).

Analysis of the component composition of the essential oil was performed by GC/MS. There are about 103 components, the main ones: α -Pinene, β -Pinene, β -Myrcene, Bornylacetate, Limonene, Germacrene D. The ratio of the main components is species-specific. In *S. gigantea* Bornylacetate (58%) and Germacrene D (to 28.2%) predominate; in *S. canadensis* - α -Pinene (to 61.2%) and Limonene (22.5%); in *S. rupestris* - α -Pinene (up 21,3%), Bornylacetate (up 20,9%), Germacrene D (28.8%) and Limonene (up 19.0%). In composition of the essential oil in *S. graminifolia* other components prevail - Sabinen -22,6%, β -Phellandrene -39,7% and β -Pinene - 14.3%. In indigenous *S. virgaurea* α -Pinene (up 33.6%) is the only major component, the proportion of other components does not exceed 7%.

Differences in quantity and composition of the essential oil component, depending on the ecological and climatic growth conditions, phenophase and the test plant's organ are revealed. It is proved that at the early flowering stage inflorescences of *S. gigantea* produce more essential oil than leaves - 0.11% vs. 0.03%.

In *S. gigantea*, depending on the population's locality, the main components' proportion varied in a wide range: α -Pinene (0,8-6,5%), Bornylacetate (9,7-57,9%), Germacrene D (0, 9-44,7%) and Limonene (0,3-4,5%). The maximal amount of essential oil (0.16%) was recorded for the plants at the northernmost collection point (N 56o51'; E 35o54') while the minimal (0.02%) - for the plants from the southernmost locality (N 47o52'; E 17o16').

Thus, the alien invasive species of *Solidago* exceed the indigenous *S. virgaurea* in quantity of essential oil and a greater variety of its main components. The significant difference in the component composition of the essential oil in *S. graminifolia* supports the legitimacy of this species' treatment within a separate genus *Euthamia*.

Keywords: *Solidago* species, essential oil, GC/MS

Impact of the alien species *Opuntia humifusa* (Cactaceae) on the native plant diversity in Bulgaria

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Opuntia humifusa (Cactaceae) is an American species which was first introduced to Bulgaria in the 1930-ties as an ornamental plant. Since then it has spread to numerous localities across the country growing in different habitats – sandy, rocky and grassy places, usually in sunny spots but also it withstands partial shading. The aim of this study was to reveal the impact of this invasive alien on the native flora and vegetation. For this purpose, 1×1 m plots with and without the invader were compared; in each locality 10 pairs of plots were studied. The following parameters were recorded: total number of vascular plant species in each plot, total vegetation cover, cover of each plant species, and maximal height of each species. The results suggest *Opuntia humifusa* is a successful competitor, significantly decreasing the available space to local plants. In some localities the species invades rare and vulnerable habitats and grows in close proximity to plant species of conservation concern. The poster presents the results of assessing the impact of the invader on the native plant diversity during two vegetation seasons.

Financial support by the Financial Mechanism of the European Economic Area (2009–2014), Programme BG03 ‘Biodiversity and Ecosystem Services’, under project ESENIAS-TOOLS is gratefully acknowledged.

Keywords: Bulgarian flora, ecological impact of invasive plants, neophytes, *Opuntia*

Studies on populations of invasive plant species in Lithuania

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The spread of alien species is creating complex challenges and poses a significant threat to the natural biological diversity, society, economic life and health of humans. Invasive plant species have considerable potential for changing community structure and ecosystem function of invaded areas. To date, more than 550 alien plant species have been registered in Lithuania and 19 of these are legally recognized as invasive species.

The aim of this research was to evaluate abundance, distribution, population structure and morphological parameters of invasive plant species as well as to estimate their impact on the state of protected species and habitats. Investigations on populations of invasive species were started in 2007. During the first stage of the implementation of the research tasks, populations of five species were surveyed. During the second stage of implementation (2014–2015), populations of 11 invasive species, i.e. *Amelanchier spicata*, *Bidens frondosa*, *Cytisus scoparius*, *Echinocystis lobata*, *Gypsophila paniculata*, *Impatiens parviflora*, *Prunus serotina*, *Robinia pseudoacacia*, *Rumex confertus*, *Solidago altissima* and *Solidago gigantea* were investigated. Studies were performed employing sampling-plot method. Herbaceous plant (including *Cytisus scoparius*) populations were evaluated in transects of 20 sampling plots of 1 m², woody plants – in transects of 10 sampling plots of 4 m². Sampled populations were selected mainly in protected areas (regional and national parks, strict nature reserves, nature reserves).

The research revealed the decrease of species diversity in the invaded habitats. Negative correlations among species diversity and both density and coverage of alien species were found in habitats invaded by *Solidago gigantea* and *Solidago altissima*. This study also revealed negative impact of invasive species on population structure and habitat conditions of the protected species such as *Linaria loeselii* (habitats invaded by *Gypsophila paniculata*), *Pulsatilla patens*, *Thesium ebracteatum* (habitats invaded by *Cytisus scoparius*), *Bolboschoenus maritimus*, *Cyperus fuscus*, *Teucrium scordium* (habitats invaded by *Bidens frondosa*).

Analysis of the data collected during the investigation revealed that invasive herbaceous plant species mainly affect open habitats, their plant communities and species diversity, whereas woody species threaten the stability of both open and forest habitats.

Keywords: habitats, impact, species diversity, population density, population structure, protected species

Topic 04

Biogeography and macroecology of invasions

P-60

The inland introduced aquatic fauna in Portugal

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The Portuguese and the European Union legislations consider the need for management of some invasive species. Presently, species lists are being prepared at E.U. level, which include the need for management. In spite of this, so far there is no thorough review of the introductions of freshwater fauna in Portugal and this is essential for the establishment of management policies and priorities.

We obtained data for 95 introductions of freshwater or eurihaline Reptiles, Fish, Amphibians, Crustaceans, Mollusks and Other Invertebrates in Portugal, including the continental territory and the Azores and Madeira Islands. With this data we were able to present a list and discuss national statistics regarding the progression of the cumulative number of introduced species since 1800, the probable vectors of the introductions, the proportions of the main taxonomic groups represented and the area of origin of the species. Furthermore, we review the current knowledge regarding invasion risk assessment studies and of invasive species distribution models in the Portuguese territory, under current and future climatic conditions.

The first major boost in the number of introductions since 1800 was in the final period of the 19th century. Along the 20th century the number of introductions increased at an approximate rate of 2 species per decade until the 1970's. Since this period, the rate of introductions increased dramatically to approximately 7 species per decade. Fish and Mollusks are the main taxonomic groups found, with more than half of the introduced species. Regarding the geographic origin of the species, most of these are from Europe and North America, representing over 70% of the species.

From the available literature, only ten species were subjected to distribution modelling and have data for the Portuguese territory. The major finding is that of the modelled species only one has fulfilled its distribution potential in the continental area. None of these models includes fish, which are the major group of introduced species and only a minority of these models provides projections for future distributions, namely under scenarios of climate change. In spite of the absence of distribution models for fish, so far risk identification tools have been applied mostly to fish on a national context.

Keywords: Freshwater, Fish, Crustaceans, Mollusks, Review, Portugal

Modelling habitat suitability to predict the invasive potential of the raccoon (*Procyon lotor*) in Luxembourg

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Accurate knowledge on species occurrence and distribution is a prerequisite for appropriate conservation or management, particularly in the case of invasive species. The raccoon (*Procyon lotor*) is a species native to North and Central America, but alien populations are established around the world, including Europe, where it is now listed within the 100 worst invasive alien species. In the introduced range, it is often assumed that raccoons may have an impact on breeding birds and amphibians, transmit pathologies to humans and other wild species, and damage crops.

In Germany, raccoon populations were confined to a relatively small area for *c.*20 years after introduction, but expansion towards new areas accelerated in the following years. In Luxembourg, raccoon presence was first confirmed in the late 1970s, but despite more than three decades of establishment, available records show that the species occupies mostly areas in the North-West of the country, with a sporadic presence in the South. However, the invasive potential of the species towards southern regions needs to be better understood.

Habitat suitability models are a useful tool that relate variables describing environmental conditions with existing species records, and use this statistical relationship to predict the suitability of unsampled sites to obtain spatially explicit and continuous surfaces indicating the probability of species occurrence.

In this study, we used nation-wide raccoon presence-only data, mostly derived from the National Biodiversity Monitoring Program, and the Maximum Entropy (MaxEnt) algorithm, to build 200-m and 1000-m resolution habitat suitability models in order to identify sites potentially suitable for future invasions at the national level. Congruent with the patterns shown by the distribution of available presence data and hunting bag data, our models suggest a higher habitat suitability in North-West Luxembourg and a relatively low suitability in the South-East region, highlighting areas where the species could already be potentially present or could expand to, given its relative suitability across Luxembourg.

Keywords: raccoon, *Procyon lotor*, invasive potential, habitat suitability models, MaxEnt

Niche shifts are common in globally invasive insectsMatthew Hill¹, Belinda Gallardo², John Terblanche¹¹*Centre of Excellence for Invasion Biology, Stellenbosch University, Matieland, South Africa*²*Pyrenean Institute of Ecology (IPE-CSIC), Zaragoza, Spain*

Invasive and pest insects have major impacts on ecosystem function, agricultural production and human health. To predict the geographic distributions of these species, correlative Ecological Niche Models (ENMs) are typically used. Such methods rely on assumptions of niche conservatism in space and time, although there is increasing evidence that many species are undergoing niche shifts during biological invasions. The magnitude and direction of niche shifts, however, is likely to vary within and between taxonomic groups, highlighting that assessment of these is required. We compiled a novel database of globally invasive insect species and test for niche shift, including geographic range expansion and unfilling, across this group. We then examine if factors such as the native range size, poleward shifts and human influence may be associated with the observed niche changes. Finally, we build ENMs for all species and examine the reliability of their predictions in light of the identified niche shift results. Niche expansion was high for this group, and apparent in 15 of the 22 species. Niche unfilling occurred in 50% of the study species. Human influence of the native range explained 50% of niche expansion, and poleward movement accounted for 40% in niche unfilling. Models suggested that species tend to invade areas with similar disturbance regimes to their native range, and that species tend to achieve their full invasive potential (low unfilling and expansion) when moving towards higher latitudes. Poleward and equatorial shifts are however associated with amounts of niche unfilling. These invasive insects undergo niche shifts that are likely associated with human influences, such as modified or transformed habitats that promote establishment and invasion of exotic species. Therefore, the use of ENMs for this group must take into considerations that these species are often not in equilibrium with their environment when making predictions of invasion potential.

Keywords: niche expansion, niche unfilling, invasive insect, invasive ants, ecological niche models (ENM), human disturbance

Linkages between ecological features and *Amorpha fruticosa* (Mill.) occurrence in selected protected areas from Romania and Slovakia

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Generally, invasive species are known to have high adaptability to new environments and human activities, thus particularly disturbed habitats have the potential to become prone to invasions. The paper is aiming to present some research findings on the relationships between ecological features and invasive false indigo-bush (*Amorpha fruticosa*) in selected wetland areas from two countries: Romania (Comana Natural Park and Mureş Floodplain Natural Park) and Slovakia (Dunajské luhy Protected Landscape Area).

The authors will perform spatial and statistical correlations in order to highlight the relationships between the selected invasive species and its main ecological conditions: soil properties, plant diversity, structural features, habitat preferences and biological indicators (abundance, frequency, coverage and ecological significance). Thus, soil sampling campaigns were carried out in each protected area, in several habitat types (e.g. agricultural, wetlands, pastures) and under specific setting conditions: areas with high abundance with *Amorpha fruticosa* and in areas without *Amorpha fruticosa*. The resulted statistical analyses will emphasize statistical dependencies between soil content (e.g. heavy metal, pH, humus, iron) and species occurrence under the specific habitat characteristics of the areas where the sampling took place. Overall, the outcomes of the current investigation will provide valuable information for further studies on modelling the potential distribution of invasive species in relation to soil parameters and main habitat features.

The current research was carried out in the framework of the EU FP7 – Building Capacity for Black Sea Catchment Observation and Assessment System supporting Sustainable Development (EnviroGRIDS) and the Inter-Academic Research Agreement between the Institute of Geography, Romanian Academy and Mlyňany Arboretum, Institute of Forest Ecology, Slovak Academy of Sciences.

Keywords: ecological features, statistical analysis, *Amorpha fruticosa*, protected areas, Romania, Slovakia

A GIS-based statistical analysis for the assessment of *Amorpha fruticosa* (Mill.) potential distribution in Comana Natural Park (Romania)

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It is acknowledged the major threat that invasive species pose to biodiversity causing significant structural and functional transformations to ecosystems. In line with that, the current study is seeking to assess the potential distribution of an invasive terrestrial plant species (ITPS) *Amorpha fruticosa* (Mill.) in a natural protected area i.e. Comana Natural Park (V IUCN category). The study-area is located in the southern part of Romania (Romanian Plain), hosting habitats, as well as plant and animal species of great scientific value overlapping the Continental biogeographical region, also designated as RAMSAR and Natura 2000 sites.

Field surveys revealed the dominance of the analyzed species in the surroundings of wetlands, river channels and alongside the transportation network, especially on the spoiled soils located next to the non-electrified railroads, as well as in the outskirts of forests. As a result, connecting this invasive species with its triggering driving forces (natural and human-induced) becomes essential in understanding its environmental preferences and predicting its potential spread. The authors propose an integrated geographical GIS-based quantitative statistical analysis aimed at assessing the occurrence, development and potential distribution of *Amorpha fruticosa* in relation to the importance of the identified key explanatory factors. The proposed methodology (potential distribution index – PODIS-I) relies on the ranking and weighting of each selected driving factor depending the relationship with the analysed species. Finally, a map displaying areas with different probability of occurrence of *A. fruticosa* in the study-area will result.

Applying an integrated methodology for assessing the spatial potential distribution of invasive plant species is particularly useful for selecting the best measures to eliminate or prevent their spreading.

The current research was undertaken in the framework of the EU FP7 – Building Capacity for Black Sea Catchment Observation and Assessment System supporting Sustainable Development (EnviroGRIDS).

Keywords: *Amorpha fruticosa*, potential distribution, statistical analysis, Comana Natural Park, Romania

Alien plants change α - and β -diversity patterns along elevation gradients: a global analysis

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Mountains are of great significance for the world's biodiversity, and in the last two decades, research about elevational species richness patterns has gained attention. Historically, biodiversity patterns have been shaped by natural factors such as climatic gradients. Nowadays, alien species may be changing biodiversity patterns along elevation gradients. Such changes might be even more pronounced due to anthropogenic habitat disturbances.

We present a global analysis of plant species diversity along elevation gradients in mountains that is based on a systematic survey in nine regions from different continents and hemispheres. We recorded the native and alien vascular plants community in plots of standardized size and equal spread along the maximum extent of the elevation gradient. Thereby we simultaneously addressed the effect of two drivers of global change: alien plants and human induced disturbance (roadsides).

Alien species richness (α -diversity) declined with elevation, while for native richness the most common pattern was a positive unimodal distribution. Alien species shifted the peak of total species richness towards lower elevations; an effect that was more pronounced at roadsides. Spatial species turnover (β -diversity) was reduced through the addition of alien species and at roadsides, but elevation did not have a consistent effect. We further found that community dissimilarity increases with elevational distance (decay-by-elevation) and that this effect was attenuated by alien species.

We conclude that although elevation is a major determinant in biodiversity assembly, it has very different effects on native and alien species and this effect is modulated by local disturbance. Our results also show that different measures of biodiversity do not necessarily respond in the same way to different global change drivers, and therefore it is important to quantify multiple dimensions of biodiversity. Further, our results underline that severe alterations of mountain biodiversity are occurring, since mountains are faced with increasing anthropogenic influence, including the introduction and spread of alien species.

This research is part of the Mountain Invasion Research Network (MIREN).

Keywords: Mountain invasions, elevation gradients, species richness, community similarity, biodiversity patterns, global change, anthropogenic disturbance

Do invasive plants in Croatia share same environmental envelopes?

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We have compared impact of three groups of environmental variables in explaining distribution of invasive plants in Croatia, i.e. climate data (presented with seasonal precipitation and mean temperature), basic topographical variables (slope, and sine and cosine of aspect) and proxies for disturbance (human population density, distance from the settlements and distance from the traffic infrastructure i.e. roads and railways). While topography variables seem to be almost irrelevant, those serving as proxies for disturbance turns out to be more important than climatic ones for significant share of invasive species (e.g. *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Chamomila suaveolens*, *Conyza bonariensis*, *Galinsoga parviflora*, *Reynoutria x bohemica*, *Veronica persica*), with particular emphasis on the population density. Among the seasonal climatic variables, the amount of precipitation was more important in explaining current distribution than the mean temperature, with exception of spring, although latter was observed in only few species with lower significance (e.g. *Amorpha fruticosa*, *Acer negundo*). Although not included in these models, and not easy to implement, it seems that invasion pathways (partly included through the disturbance proxies) could play one of the main roles in explaining significant number of invasive plant distribution. There is no doubt that prevailing environmental conditions sets up the scene, but pathways might be dominant factor that do the casting i.e. selecting the species that will have chance to express their invasiveness.

Keywords: Croatia, distribution, modelling, GIS

European anthropogenic, semi-natural and natural habitats as sources of naturalized plant species worldwide

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Large-scale patterns of plant invasion and their determinants in different habitat types are receiving increasing attention. This research has mainly focused on invasion in habitats in recipient areas, but recently also the importance of habitat types from which alien species originated in the source areas is recognised as a factor controlling observed patterns. We explored European anthropogenic, semi-natural and natural habitats as sources of plants that became naturalised in other parts of the World. Our dataset encompassed 10,741 vascular plant species assigned to 37 habitat types classified into habitat groups reflecting the intensity of human impact, based on European vegetation classification system (Mucina et al. submitted). Within each habitat type and habitat group, species naturalised outside Europe were identified using the GloNAF database (van Kleunen et al. 2015). European habitat types, providing the highest proportion of naturalized species, included anthropogenic weed and perennial ruderal vegetation, semi-natural to natural grasslands and wetlands, riparian forests, and eutrophic forests, and species from these habitats were also most successful in terms of the number of GloNAF regions occupied. The European species with the widest naturalization range, as measured by the sum of regions in which they naturalized, originated in anthropogenic weed vegetation. Successful were also species occurring in both semi-natural grasslands and weed vegetation. Among species of natural habitat types, generalists able to occur in anthropogenic as well as in semi-natural habitat types have naturalised most frequently.

Keywords: alien plant species, donor habitat, native range

What is the role of vacant niches for alien species establishment on isolated islands?

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Globally, islands are major biodiversity hotspots. The intrinsic properties of islands promote the evolution of highly specialized and range-restricted native biota which is mainly driven by island area, age and isolation. Isolation restricts natural dispersal of species, leading to the absence of some functional groups in the local species pool that play a key role in mainland regions. It has been suggested that such empty ecological space may facilitate establishment of new species and contribute to the high levels of biological invasions widely observed on islands worldwide.

We test the importance of “vacant niches” to explain differences in the level of invasion in a wide range of subtropical and tropical islands and island groups. The dataset encompasses information on established alien species richness from a range of important taxonomic groups that represent plants (vascular plants), vertebrates (mammals, amphibians, reptiles) and invertebrates (ants). We assess the effect of island isolation on alien species numbers and on the observed level of invasion while accounting for area, climate and physical as well as economic properties of islands by means of generalized linear mixed effect models. We will present results of this analysis, which are highly relevant for understanding the biogeography and macroecology of island invasions and to inform alien species management and policy.

Keywords: alien species, ants, amphibians, biogeography, introduction effort, isolation, macroecology, mammals, reptiles, vacant niches, vascular plants

A dynamic modeling approach for estimating the potential distribution of the invasive Asian *Ambrosia* beetle *Xyleborus glabratus* Eichhoff in North America

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Since its introduction to the east coast of the United States in 2002, the fungus *Raffaelea lauricola* T.C. Harr., Fraedrich & Aghayeva, which is transmitted by the ambrosia beetle *Xyleborus glabratus* Eichhoff (Coleoptera: Curculionidae: Scolytinae), has caused major mortalities to species of trees in the Lauraceae family. Here we present the predictions of the invasion dynamics of *X. glabratus* 25 years after its introduction across North America using a spatially explicit dynamic modeling approach based on a logistic growth model that incorporates dispersal. Results show how the distribution of the species is shaped by a heterogeneous set of favourable conditions (belonging to the abiotic ecological niche) and resource availability (distribution of Lauraceae tree species) and could replicate the known distributional pattern for this beetle from 2002 to 2015 in the United States. Results also indicate that this modeling approach has several advantages over correlative approximations to detect and predict species' distributions. The incorporation of population processes associated to the intrinsic population growth rate and dispersal in process-based modeling represents an advantage when modeling species geographic distributions because these allow us estimating the relevance of parameters related to the movement and colonization of the species in contrast to solely the abiotic ecological niche, thus providing a better means of assessing the potential distribution of a given species through time. This in turn allows us estimating how the process of dispersal and colonization can be achieved by the species depending on the initial conditions, which inform us on the potential success of an invasion.

Keywords: ambrosia beetle, ecological niche, invasive species, potential distribution, suitability, process-based modeling

Effect of alien species on the phylogenetic structure of plant species pools*Zdeňka Lososová, et al.**Dept. of Botany and Zoology, Masaryk University, Brno, Czech Republic*

One of the key questions of invasion biology is to identify which factors facilitate species invasion. A number of hypotheses postulate that invasion is strongly influenced by the interplay between the phylogeny of the alien species and the phylogenetic structure of invaded communities. Some hypotheses predict that aliens phylogenetically related to native species in invaded communities are more successful invaders, because of appropriate niche-adaptation. Another hypothesis predicts that phylogenetic relatedness hampers naturalization because of niche overlap with native species. We thus asked whether or not differences in the phylogenetic structure of native species pools affect the number of alien species. We used species pools of 88 vegetation types occurring in central Europe, comprising 2306 species. For each species pool, we quantified phylogenetic diversity using mpd and mntd indices to test the relationship between it and the level of invasion. The level of invasion was strongly vegetation-type dependent, and it was related to both the phylogenetic structure of the species pools, and the phylogenies of the invading species. The species pools with the largest proportion of alien species were those of anthropogenic habitats and open riverine, wet or mesic meadows. These species pools are phylogenetically more clustered possibly due to disturbance acting as environmental filter. Here, alien species increased the degree of phylogenetic clustering as they tended to be from the same lineages as native species. Such trends were not detected for phylogenetically diverse species pools such as those of forests. Our findings do not support the Darwin's naturalization hypothesis; they rather suggest that the alternative hypothesis of environmental filtering is the important mechanism in play.

Keywords: Archaeophyte, biological invasions, neophyte, phylogenetic diversity, species pool, vegetation type.

P-71

Urban plant communities: testing the mesic hypothesis of invasibility

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Urban land use provides new habitats by creating new combinations of abiotic factors and by bringing together species that otherwise would live in different regions of the world or in different habitats within the same region. Current urban plant communities are thus composed of native as well as alien species and the level of invasibility of urban communities varies between habitats and climatic regions.

The aims of our study were to identify factors which shape structure and function of urban plant communities, to determine relationships between structure of urban communities and their invasibility. Specifically, we tested the mesic hypothesis of plant invasibility, which predicts that the level of invasion is higher in mesic environments than in both dry/warm and cold/wet environments. We tested this hypothesis using a data set of 420 vegetation plots from different urban habitats of 60 large European cities.

Keywords: Europe, level of invasion, urban ecology, urban habitat

Factors explaining the historical and present distribution of an invasive species, *Ventenata dubia*, in its native range

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Ventenata dubia is a species of grass of conservation concern in many parts of Europe. Its historical range has shifted, and places where it was once abundant, it has become rare, or even extinct in some cases. This species is of particular interest because while rare in its native range, it has become highly invasive in the United States. Several factors may have influenced the distribution of this species. First, the northward shift in its range over time suggests climate could be an important factor. Second, *Ventenata* has historically been found in areas with frequent low intensity disturbance, and therefore land use change may also play an important role. Understanding how these biogeographical factors influence *Ventenata*'s distribution in its native range, may help us understand both its threatened status in Europe, and why it has become a pest in north America.

The objective of our study was therefore to determine if there has been a range shift of this species in its native range, and to assess the role that climate and land use change have had on the distribution. Secondly we compare the native and invasive ranges to determine whether or not the species distribution in the two ranges is limited by similar biogeographical factors. Using presence data from a combination of herbarium specimens, floristic survey data, literature reviews, and field surveys, we assessed the historical and current distribution of *Ventenata* throughout its native and invasive ranges. In combination with climate and land use data, we construct species distribution models for *Ventenata*. Our results could both aid in the conservation of this species in its native range, and be used to inform predictive models of this species' spread in its invasive range.

Keywords: *Ventenata dubia*, range shifts, species distributions, invasive species, biogeography, Niche shifts

Alien ladybirds (Coccinellidae) established in European Russia and neighbouring countries

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More than 20 species of Coccinellidae were introduced for pest control in the Soviet Union. Six of them have established.

(1) *Chilocorus bijugus* was introduced from India to Georgia in 1973 to control *Quadraspidiotus perniciosus* and established near Batumi.

(2) *Cryptolaemus montrouzieri* native for Australia was released to control Pseudococcidae and Coccidae many times from 1933 in different regions including Abkhazia, Azerbaijan, Uzbekistan, but thought to be not established. In 2011 and 2012 established populations were found in the south of Russia (Sochi) and Abkhazia.

(3) *Harmonia axyridis* from the Far East was released for control of aphids in Georgia, the Ukraine, Belarus and Kazakhstan. In spite of massive releases since 1927 the species was thought to be not established before 2002. Now it is established in the Ukraine, Moldova, Belarus and European Russia: Kaliningrad, Rostov, Krasnodar and Stavropol regions, Adygea, the Crimea, Dagestan, Kabardino-Balkaria. Individual adults are also found in Belgorod, Lipetsk and Moscow regions. In some regions individual specimens were found well before the eastern border of European range became close: in 2002 in Eastern Georgia, in 2005 in Abkhazia, in 2003 in Kiev (the Ukraine). The population exists near Kiev since 2007. Population in southeastern Kazakhstan and Kirgizstan is neither native nor a result of intentional introduction and appeared as a result of unintentional introduction from the western part of the native range.

(4) *Lindorus lophantae* native to Australia was released for control of Diaspididae in 1948 in Georgia, Crimea south Russia. Established population was detected in Georgia. The whole population of *L. lophantae* in the Caucasus derives from laboratory culture, established from just one pair of insects collected in Italy.

(5) *Rodolia cardinalis* native to Australia was released to control *Icerya purchasi* in Georgia and Azerbaijan (many releases since 1932) and established in the Black Sea shore. Current state of population is unknown.

(6) *Serangium parcesetosum* native to India was released in 1973 in Georgia, Abkhazia, Azerbaijan and south Russia (Sochi) to control *Dialeurodes citri* (Aleyrodidae). *S. parcesetosum* established and began to spread spontaneously. The local populations were renovated by additional releases from laboratory culture.

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Keywords: biocontrol, *Chilocorus bijugus*, *Cryptolaemus montrouzieri*, *Harmonia axyridis*, *Lindorus lophantae*, *Rodolia cardinalis*, *Serangium parcesetosum*

On population abundance and species niche relationship during invasion process

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Although it has been well documented that species ranges are the result of successful past invasions, the theoretical aspects of how the invasion process occurs remains as a relevant question in ecology. To gain insight into the understanding of the process, ecologists and mathematicians have proposed models that take into account mechanisms that affect the patterns of species spread; two frequently considered mechanisms are I) the Allee effect which has been shown to hamper or prevent species invasions depending on its intensity and II) the effect that heterogeneous environment has on species distribution and spread. Here we provide an alternative way to model Allee effects and analyse the spread of a population in terms of its relationship with species niche. The results show that the long term species distribution patterns are independent from the way that the Allee effect is included in the logistic growth model. However, we observed that population abundance patterns in the short term dynamics are very sensitive to the considered model. This fact can have important consequences in the prediction of how the invasion process occurs in nature, for example in the estimation of the arriving time of an invasive species to a certain location.

Keywords: Allee effects, ecological niche, invasion process, distribution patterns, population spread

Global Naturalized Alien Flora (GloNAF), a new and powerful resource for understanding plant invasions worldwide

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Despite intensive research on plant invasions, a robust global database of regional alien floras has been missing up to now. Thus, statements regarding major patterns and the importance of plant invasions were supported only by data from few regions, and in the vast majority of instances based on species numbers and not the composition of complete alien floras. Here we introduce the Global Naturalized Alien Flora (GloNAF) project, initiated in 2011, and associated database covering the whole world, and summarizing information on naturalized floras for over 840 terrestrial regions. By launching the database in 2015 we were able to describe and quantify, for the first time, the global biogeographic, taxonomic and phylogenetic patterns of naturalized alien plants.

The first paper based on GloNAF (van Kleunen et al. 2015) revealed that in total, ~12,000 plant species, which correspond to ~4% of the extant vascular flora, have become naturalized somewhere on the globe, and identified the regions that have accumulated the largest number of naturalized species (Europe, North America). Moreover, the study showed that the traditional global dichotomy of the Old World donating and New World receiving naturalized plants needs to be reconsidered; rather, the Northern Hemisphere is a major donor of naturalized plants to other parts of the world. These results demonstrated, for the first time at the scale of the whole world, that naturalization processes are not random phenomena, but exhibit clear phylogenetic and biogeographic patterns.

Since the publication of the van Kleunen et al. (2015) paper, the GloNAF database has served as a unique data source for testing various hypotheses of invasion mechanisms, as well as for comparing invasion patterns of plants with a wide range of animal taxonomic groups. The contribution of GloNAF so far has been both to support and challenge conventional wisdom about biological invasions. In the presented poster, we summarize major findings yielded by analysing the GloNAF database and outline areas whether it may become a key tool for better understanding plant invasions globally.

Reference: van Kleunen M., Dawson W., Essl F., Pergl J., Winter M., Weber E., Kreft H., Weigelt P., & Pyšek P. (2015): Global exchange and accumulation of non-native plants. *Nature* 525: 100–103.

Keywords: plant naturalization, global scale, species richness

Towards a checklist of the alien plants in Turkey

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Turkey has more than 12,000 plant species, as a result of the high diversity of climates, geographies, and soils and being a biogeographic crossroads. The Flora of Turkey was prepared in the last century followed by new attempts to make it covering all species with new explorations and including detailed information about all taxa, and new studies are revealing new species for this county. Almost 30% of the species in Turkey are endemic and Turkey is at the crossroad of two important centres of diversity of wild crop relatives, that are the Mediterranean and the Middle East centre and three phytogeographic regions which are Euro Siberia, Mediterranean and Irano-Turanian. Although the flora of Turkey is well documented, there are still some gaps. For example, the traditional floras do not provide specific information on alien (invasive alien) species except a few notes. We developed an on-going initiative and working group aiming to collect all the available information and compiling a list of the alien plants in Turkey. We present the main results of the preliminary list of the alien plants of Turkey, on the base of a preliminary checklist for Turkish alien flora, which covers currently 469 species. The checklist and the supporting database hold information and details on botanical features of alien plants (casual, naturalised, invasive), purpose of introduction, regional distributions and presence in different phytogeographic regions of Turkey. The number of alien taxa in Turkey comparing to total species in Turkish flora and the number of alien species in other regions of the world seem lower, which indicates further observations and activities necessary in Turkey on invasive alien plants.

Keywords: Check list, invasive alien plants, Turkey, flora

Topic 05

Invasive species and changes in landuse

P-77

Of factors affecting the abundance of *Impatiens glandulifera* and its spread from river corridors

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Riparian habitats belong to the most invaded ecosystems worldwide. The great abundance of invasive species in river corridors is attributed to efficient transport of alien species' propagules, and reduced competition from native plants due to regular disturbances by flooding. Once an invasive species has become established, river corridors can also serve as stepping stones for spread to other habitats. Our study species, Himalayan balsam *Impatiens glandulifera* Royle, is an annual from the Himalayas, which invades massively along rivers in the temperate regions, but occurs in a broad range of habitats, including other than riparian. We mapped its distribution and recorded its abundance in over 1200 plots along four rivers in central Europe, covering the total of 158 km of watercourse. The rivers differed in the time of the balsam's introduction (1900–1995) and beginning of the spread of its populations, and plots were characterized by degree of soil disturbance and flooding regime. The populations in flooded zones were on average two-times larger than those in non-flooded, regardless of their distance from the riverbank and elevation above river surface. There was a strong effect of the residence time at the site, with river invaded 20 years ago being significantly less infested than those invaded earlier. The rivers differed in the distance from the bank to which the populations penetrated into the surrounding habitats, but this distance did not depend on the residence time. The populations on tributaries were on average two-times farther from the riverbank than those not located on tributaries. A high number of small populations found rather far from the river banks indicates a good dispersal ability of *I. glandulifera* and the key role played by stochastic dispersal events. However, the persistence of these populations is ephemeral, as only few of them were rather extensive, and the majority of them were in early stages of vegetation succession. We suggest that the number of *I. glandulifera* populations is likely to increase in the future, especially along small water streams. Flooding is important predictor of abundance of *I. glandulifera*, and probably supports the spread and dominance of *I. glandulifera* in the river corridors.



Impatiens glandulifera growing untypically from the wall of a castle ruins.

Keywords: balsam, river corridor, disturbance, flood, naturalization, niche broadening, residence time, riverbank

Dependence of alien plant species abundance in grassland habitats on the intensity of land-use

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In 2015, during the inventory and mapping of open habitats according to the EUNIS habitat classification in two protected areas of Lithuania, Gražutė and Kurtuvėnai regional parks (hereafter – Gražutė RP and Kurtuvėnai RP), the diversity and abundance of alien species were estimated alongside of other characteristics of habitats. As a result of the inventory, 1 076 plots of open habitats in Gražutė RP and 775 plots in Kurtuvėnai RP were assessed and mapped. Open habitats occupy 5 656 ha in Gražutė RP (17.7% of the total park area), whereas in Kurtuvėnai RP, they occupy 2 342 ha (13.5% of the total park area).

In Gražutė RP, grassland habitats in 829 plots were inventoried, which occupy 4694.2 ha. Alien plant species were recorded in 728 grassland habitat plots and only in 101 plots of these habitats alien plant species were absent. Thus, in Gražutė RP, 87.8% of all grassland habitat plots were invaded by at least one alien species and such habitats occupy 4 360.4 ha or 92.9% of all inventoried grassland habitats. In Kurtuvėnai RP, grassland habitats were inventoried in 528 plots, which occupy 1 778.7 ha. Alien plant species were registered in 352 grassland habitat plots and in 176 plots alien plant species were not recorded. Thus, in Kurtuvėnai RP, 66.7% of all grassland habitat plots were invaded by at least one alien plant species and such habitats occupy 1030.7 ha or 57.9% of all inventoried grassland habitats.

The most frequent alien species in both regional parks was *Lupinus polyphyllus*, which was registered in 907 plots of grassland habitats. Other alien species were less frequent: *Erigeron strigosus* was recorded in 209 plots, *Malus domestica* – in 165 plots, *Prunus cerasifera* – in 127 plots. The most dangerous invasive species, *Heracleum sosnowskyi*, was recorded in 27 grassland habitat plots. In Kurtuvėnai RP, a total of 16 alien plant species were recorded occurring in grassland habitats, whereas in Gražutė RP, the number of alien species in these habitats was much higher – 58 species.

The number and abundance of alien plant species is related to the character and intensity of grassland habitat use. Abandoned grasslands were the most heavily invaded by alien plant species, whereas in moderately and intensively used grasslands (grazed, mown or both), the number and abundance of alien species was significantly lower. Dry and mesic grasslands are much more prone to invasions than wet grasslands. The main causes of alien plant invasion to grasslands are their abandonment or irregular and insufficient usage.

Keywords: abandonment, EUNIS habitats, grazing, habitat invasibility, mapping, mowing

Monitoring the long-term persistence of a golden jackal (*Canis aureus*) in a colonized habitat in the Czech Republic: initial phase of the establishment live?

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The presence of a golden jackal (*Canis aureus*) individual, captured ca 40 km east of Prague in the Czech Republic by camera traps set up in a range of different habitats, has been monitored for 10 months. It was first photographed on 19 June 2015, and in total there were 55 records made by 12 traps until 24 March 2016 when the animal was still present. The majority of records are from a shrubby grassland, but the animal also occurs in a neighbouring deciduous forest, with the total range of its occurrence exceeding ca 100 ha; 41% of sightings were during the day and 59% in the night. This observation represents the first evidence of a long-term occurrence in Europe northwest of Hungarian-Austrian border where the population has been known to reproduce, of the same golden jackal individual that persisted over winter.

Opinion on the status of golden jackal in European regions to which it currently spreads is ambiguous. While in Baltic countries its recent expansion generated concerns about its possible negative effects on other wildlife species and livestock, via predation or transmission of pathogens, which led to it being labelled as potentially invasive alien species, the prevailing opinion in other countries does not support this attitude. In the paper we discuss this issue.

Keywords: golden jackal, range expansion, Czech Republic

First record of the species *Pantomorus cervinus* Boheman, 1840 (Coleoptera: Curculionidae) on the invasive alien species *Verbascum thapsus* L. in Hawaii – Big Island, USA

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Like any other ecosystems of islands, the Pacific Big Island of Hawaii archipelago, appear to be particularly vulnerable to alien invasive species (AIS), from any taxonomic group of flora and fauna of the Earth. Beyond of this justifiable concern the new enlarged studies are necessary regarding the assessment of risk of AIS introduction and, also to the relationships between endemic local populations. *Verbascum thapsus* L. (Scrophulariales: Scrophulariaceae), common mullein, or mullein in Hawaii state had the status of invasive species according with Hawaii State-listed Noxious Weeds, PLANTS Database, USDA Natural Resources Conservation Service. It is clear that predictable overview about the magnitude of impact and habitat altering local population growth and dynamic are not yet established. Biological control seems to be the best method but is far to be considered the most efficient but the community of scientists and environmental managers is seeking to bring the safest yet most effective insect agent in any related case.

The present paper investigates the possibility to find in the local community of plants populations an option, beyond the introduction of an exotic biocontrol agent, that should be considered like a management option for classical biological control and we record for the first time a new pest for mullein species, the weevil Fuller rose beetle *Pantomorus cervinus* (Boheman, 1840). In the paper ecological and biological considerations about guild relationships between the two species are discussed.

Keywords: AIS, *Pantomorus cervinus*, biological control, invasive status

P-81

***Harmonia axyridis* Pallas 1773 (Coleoptera: Coccinellidae) a review of its biology, ecology and risk assessment on intraguild predations in Romania**

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The harlequin ladybird, *Harmonia axyridis* Pall., has been considered both one of the best biological agent of many pest species or as a pest invasive species.

Recorded for the first time in Romania in summer 2008 in the present most authors consider the status of species as successfully established but the impact of this fact remain, in most part unclear.

The present paper discusses the distribution, the spread, the mass rearing in controlled conditions and some ecological consideration related to relationships with other species of native ladybirds.

Keywords: *Harmonia axyridis*, risk assessment, biological control

Using spatially explicit dynamic modelling to predict future invasion dynamics

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Biological invasions are a threat to global biodiversity, imposing severe impacts on the environmental, social and economic determinants of human well-being. Specifically, invasive woody plant species (IWPS) have the ability to profoundly alter many forest ecosystems, namely their structure and functioning, which are the backbone of forest productivity, stability and resilience. IWPS can disrupt the provision of ecosystem services, triggering hardly reversible regime shifts in human-derived benefits, from forests, timber provisioning and climate mitigation, to water regulation, soil erosion and fire control. We will present an integrative predictive modelling framework aimed to advance the current and future applications of ecological modelling in the assessment of biological invasions as drivers of socio-ecological regime shifts in forest landscapes. In this framework, niche models and remotely sensed forest attributes jointly feed a spatially-explicit dynamic model. We illustrate our approach with a dynamic model developed for *Acacia dealbata* to simulate population dynamics under current and future socio-environmental conditions in forest landscapes. Distinct management strategies for different *Acacia* height classes are considered to simulate the cost-efficiency of individual or combined techniques. Additionally, the conditions of climate, land use, management and fire disturbance that can promote the spread of *A. dealbata* towards non-invaded areas are analysed, tested and optimized under contrasting socio-ecological scenarios. Our results highlight the adequate management actions for the aggressive invader *A. dealbata*, identifying landscape and forestry management regimes that could effectively prevent new invasions. Finally, we discuss the potential of the framework for evaluating the circumstances under which regime shifts in forest ecosystems, triggered by IWPS, can be anticipated and prevented.

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Keywords: dynamic modelling, invasion, invader alien plant species, regime shift, land use change modelling, socio-ecology

Flora of Moscow railways

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Main botanical garden, Moscow, Russia

The results of the Flora of Moscow railways studies since 1851 (date of the first railroad in Russia foundation) till 2015 are summarized. The check-list comprises 1119 species (499 indigenous, 620 alien), belonging to 93 families. Within alien component of the Flora several important differences compare to indigenous component are recorded: the list of 13 leading families does not include Cyperaceae, ranks of Caryophyllaceae and Scrophulariaceae are lower, while Chenopodiaceae, Apiaceae and Boraginaceae are higher in ranking. Annuals absolutely prevail in life-form spectrum (46%); a group of perennial herbaceous plants includes 212 spp. (34%), trees, shrubs and woody vines have 123 spp. (20%). 351 alien species can be characterized as occasionally contaminated, 269 – as escaped from cultivation. A group of casual alien plants consists of 222 spp. (36%); a group of naturalized plants prevail (48%); 41 invasive species s. str. (7%) and 59 transformers (9%) are recorded. 54% of all alien plants recorded for Moscow region (Moscow plus Moscow province) grow along railways. A few new species for former USSR territory were found there (*Rubus macrophyllus*, *Polygonum ramosissimum*), as well as many new species for Moscow province (*Gypsophila perfoliata*, *Hyssopus officinalis*, etc.). Some alien plants grow along railways for decades: e.g., *Urtica cannabina* and *Asclepias syriaca* grow within the same locus for more than 30 years, demonstrating no tendency to further expansion. Railways are not only “donors/sources” of alien species, they are also their recipients. In fact, railways could serve as a refugium for “the escapees”: e.g., *Asclepias syriaca* grow over 30 years within the section of railway Kursk-Moscow located near Institute of Medicine Plants. *Galega officinalis* was also recorded for the spot 10 years ago, and now this species forms the dense population of about 200 m². *Sedum hispanicum* and *S. album* appeared along the railways from flower gardens located near railroads. There is a strong correlation between plants' life form and pathway. In the group of woody plants “the escapees” predominate (10 times more species than within the group of occasionally contaminated plants). Within the group of herbaceous perennials occasionally contaminated plants have 2 times more species than in the group of “the escapees”. Within the group of annuals occasionally contaminated plants are 3 times more numerous in species than “the escapees”. Consistent patterns of naturalization processes in flora of railways and its alien fraction for the Moscow region are similar.

Keywords: railways, Moscow, flora, invasive species

Current and potential distribution of *Solidago* ×*niederederi* (Asteraceae) in Poland

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Solidago ×*niederederi* Khek (Asteraceae) has been recorded in several countries in Europe as a result of spontaneous hybridisation between the alien *S. canadensis* L. and the native *S. virgaurea* L. The hybrid is found in anthropogenic habitats, usually close to both parents, and it forms characteristic clonal clumps that consist of a few, several or several dozen stems. It is intermediate in the general features of synflorescence and leaf morphology.

Field studies conducted in 2013-2015 in Poland reveal that the hybrid occurs mainly on abandoned fields and is more frequent than previously thought. Currently, it is known from thirty 10-km square units of the ATPOL cartogram grid. It is clear that its distribution is dependent on that of the parental species. The potential distribution of *S.* ×*niederederi* in Poland shows that invasion of *S. canadensis* by hybridisation with a native congener may happen throughout the whole territory of the country. Most populations are small and are probably casual rather than established, however, the persistence and spread of the hybrid need further study.

Keywords: *Solidago canadensis*, *Solidago* ×*niederederi*, invasive species, plant hybridisation, Poland

Dynamics of selected invasive species in the Polish Carpathians and their Foreland

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A study encompasses the dynamics of 17 invasive taxa recorded in the Polish Carpathians and their forelands in 1850-2015. Database consists of 19.905 records. For each species and year a total number of localities were noted and arranged in a data matrix used for the ordination and classification procedures: non-metric dimensional scaling (NMDS) and classification with Ward (minimum variance) algorithm based on Euclidean distances. Both the ordination and classification methods showed 5 groups. The first (group A) consisted of *Impatiens parviflora*, *Solidago gigantea* and *Reynoutria japonica*. The group had the highest loadings along the first axis of NMDS ordination and formed a distinct group in Ward's classification. The second was B2 group consisted of six species: *Epilobium ciliatum*, *Solidago canadensis*, *Rudbeckia laciniata*, *Bidens frondosa*, *Acer negundo*, and *Echinocystis lobata*. The remaining B1 group had three well-distinguished subgroups B1A, B1B, and B1C. They formed a sister group to B2 group in the classification diagram and were well discriminated in the ordination space. Subgroup B1A had two species: *Heracleum mantegazianum* and *Heracleum sosnowskyi*; subgroup B1B three species: *Lycium barbatum*, *Elodea canadensis*, *Onobrychis viciifolia*; subgroup B1C three species: *Bunias orientalis*, *Padus serotina*, and *Veronica filiformis*. Maximum increase in species localities was noted in 1960-1980. The most earliest in the Polish Carpathians was noted group B1B, as early as in the second half of the 19. century. B1C and B2 were noted some 100 hundred years ago, and B1A was the latest and appeared in the region some 30 years ago. For some pairs of species a highly synchronous and periodic dynamics were found.

Keywords: invasive species, dynamics in time and space, Polish Carpathian Mountains

Urban ornamental trees: a source of recent invaders? A case study from European city

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Man-made habitats are considered to be the important hotspots for species naturalization. Due to high propagule pressure caused by human activities they serve as a source of introduction of alien plant species. We used the database of cultivated ornamental trees and shrubs for Brno, Czech Republic, to determine the significance of introduction pressure as a factor in woody plant naturalization. From all cultivated woody taxa, 15 % was recognized as spontaneously growing in the urban area and there was a significant relationship between the frequency of cultivated species and their ability to spontaneously occur in urban area. The highest potential to spread from cultivations have temperate Europe native species, followed by neophytes originated from America or Central and Eastern Asia, respectively.

Keywords: Archaeophyte, Europe, invasive biology, native species, neophyte, propagule pressure, urban ecology

Topic 06

Non-native pests and pathogens

P-87

Alien species of Sternorrhyncha (Insecta, Hemipteroidea) as non-native pests of ornamental plants in Belarus

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Sternorrhyncha is a taxon of Hemipteroidea which includes whiteflies (Aleyrodinea), aphids (Aphidoidea), phylloxerans and adelgids (Phylloxeroidea), scale insects (Coccoidea), and jumping plant lice (Psylloidea). A number of these phytophagous insects damage ornamental plants.

There are two large groups of alien Sternorrhyncha species pestful for decorative cultures. The first ones are dangerous pests of ornamental plants which grown in greenhouses or indoors. Among them whitefly *Trialeurodes vaporariorum* (Westwood 1856), scale insects *Coccus hesperidum* Linnaeus 1758, *Saissetia coffeae* (Walker 1852), *Aonidia lauri* (Bouché 1833), *Aspidiotus nerii* Bouché 1833, *Diaspis boisduvalii* Signoret 1869, *Pseudococcus longispinus* (Targioni Tozzetti 1867), *Pseudococcus maritimus* (Ehrhorn 1900), *Vryburgia amaryllidis* (Bouché 1937), aphids *Neomyzus circumflexus* (Buckton 1876), *Myzus ascalonicus* Doncaster 1946, *Myzus persicae* (Šulzer 1776), *Macrosiphoniella sanborni* (Gillette 1908), etc. Outdoors same of them form only temporary seasonal populations during warm season because failure to overwintering under the environmental condition of Belarus.

The second ones naturalized under the condition environmental of the region and their populations are more or less stable. These species are common or abundant at least in parks, gardens or orchards. Twelve of them have been included in Black List of invasive animals for the country.

Keywords: bioinvasions, Aleyrodinea, Aphidoidea, Coccoidea, sucking insects

Native Parasitoid Assemblages of an invasive pest, *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae), in Slovenia, Croatia and Hungary

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The Asian sweet chestnut gallwasp, *Dryocosmus kuriphilus* Yasumatsu (DK) (Hymenoptera, Cynipidae) considered to be the most important pest of chestnut worldwide. Originating from China, this pest was accidentally introduced to Japan in 1941, colonized Korea in 1958 and the USA in 1974. In 2002 it was detected in Europe, Italy. Since then DK spread throughout Italy and has also been reported in all European countries where chestnut growth.

Within the native range in China, 11 parasitoid species were found to associate with DK which kept the host populations at low densities; in Japan, South Korea, the USA and European countries the attack rates of indigenous parasitoid species vary from 2% to 4.7%, in some regions of Italy occasionally up to 32%. We study the native parasitoid assemblages of DK across its expanding range in Italy (since 2005), Slovenia (since 2010), Croatia (since 2011) and Hungary (since 2013). All parasitoid species are known to associate with oak cynipid galls. Most of them are generalists that can shift hosts more easily and are more successful in colonizing an invasive host and thus a large parasitoid diversity within the DK community can be expected. The aim was to study the source community of parasitoids available to attack the invasive host and the way in which they may associate with *D. kuriphilus*. Specifically, (i) are parasitoids conservative in their choice of host, jump onto the new invader rarely and track the host after a suitable match between parasitoid and host is established (the Host Tracking hypothesis) or (ii) are parasitoids opportunistic and readily jump onto a new host from their local population when it becomes available (the Local Recruitment hypothesis). We believe that Local Recruitment is the more likely hypothesis to explain interactions between native parasitoids and DK. Around half of parasitoid species associated with DK across its expanding range, were not observed in the original site of invasion, thus the Host Tracking is unlikely to be happened. Since 2005 44 species shifted onto the new pest, DK. Till 2015 in Italy 39 chalcidoid parasitoid species have so far recruited naturally to the new host, in Slovenia 28, in Croatia 20, in Hungary 17. The time lag between the introduction of the new host, DK, and the recruitment of native parasitoid community is short and depends on the longevity of pest's presence on a particular site. Recruitment of parasitoids to DK depends on actual parasitoid species composition of oak gallwasps to be found in the same locality and vary from year to year.

Keywords: invasive pest, *Dryocosmus kuriphilus*, native parasitoids, augmentation, biological control, parasitization rate

The crayfish plague pathogen, *Aphanomyces astaci*: pathways, vectors and potential consequences of its spread in the introduced ranges

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The crayfish plague pathogen *Aphanomyces astaci* is a parasite that, due to its devastating impact on European crayfish species, was listed among 100 world's worst invasive alien species. Crayfish plague is mainly spread by its natural hosts, North American crayfish. Thanks to a long co-evolutionary history with *A. astaci*, they evolved efficient defence mechanisms that susceptible European, Australian and Asian crayfish species lack. Several North American crayfish, especially the red swamp crayfish *Procambarus clarkii*, got established on different continents thanks to stocking into open waters and aquaculture. In Europe, the spread of *P. clarkii* is responsible for *A. astaci* transmission to native crayfish species; therefore, its presence may endanger endemic crayfish also elsewhere in the world. As the first such case, we confirmed presence of *A. astaci* infections in Japanese populations of *P. clarkii*, and of the signal crayfish *Pacifastacus leniusculus*. In that country, crayfish plague might have contributed to declines of the local endemic crayfish *Cambaroides japonicus*. Apart from aquaculture, freshwater crayfish are also becoming very popular pets, and a recent rapid growth in aquarium trade coincides in Europe with their releases into open waters. After screening for *A. astaci* presence in various non-European crayfish species circulating in German ornamental trade, we confirmed that aquarium trade represents also a source of exotic pathogens, including *A. astaci*. Thus, crayfish plague may be transmitted to the natural environment by crayfish released from household aquaria. Even aquaculture or ornamental crayfish species of non-American origin may contribute to crayfish plague spread. Although they are generally regarded as susceptible to *A. astaci* and expected to die shortly after an infection, at least some widely traded crayfish species apparently show elevated resistance. We experimentally demonstrated that the Australian yabby *Cherax destructor* is indeed less susceptible to *A. astaci* than European crayfish species, and its release may result in formation of new pathogen reservoirs. The presentation will summarize outcomes of projects undertaken during the first author's PhD studies that concern *A. astaci* introduction pathways, vectors and reservoirs. These results will be presented with regard to *A. astaci* genetic variation (responsible for differences in virulence and tolerance to varying environmental conditions) and discussed in relation to existing regulations and potential preventive measures aiming to reduce the risk of *A. astaci* spread.

Keywords: North American crayfish, disease outbreaks, aquarium trade, aquaculture, host-pathogen interactions, pathogen reservoirs

P-90

Identification of walnut husk (*Juglans regia*) volatiles and behavioral response of the invasive Walnut Husk Fly, *Rhagoletis completa*

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Background:

Several European countries are important walnut producers. They however have to deal with the recent introduction of the Walnut Husk Fly, *Rhagoletis completa* (Diptera, Tephritidae), that causes severe economic losses, especially in biological productions. Because most Tephritidae fruit flies use kairomone from their host in their search for host, we hypothesize that this highly specialist species orientate toward the volatile blend released by walnut husk.

Results:

First, we collected, identified and quantified the volatile organic chemicals (VOCs) released by walnut husks collected from the most cultivated variety in France (Franquette). Then, the behavioural response of *R. completa* toward natural and synthetic odor blends was recorded in a fly tunnel. A total of 26 VOCs were identified, including α -pinene, β -pinene, trans-linalool, eugenol, tetradecane as the major constituents. In the fly tunnel, males and females *R. completa* were strongly attracted by fresh walnut husks as well as by a synthetic blend including most of the previously identified husk COVs.

Conclusion:

Coupled with yellow traps, this kairomone blend could improve the efficiency of the monitoring efforts, but could also be used for the management of this quarantine pest.

Keywords: Fruit flies, Volatile organic compounds, Integrated pest management, Walnuts

Investigation on dispersion and feeding behaviour of non-native stink bug pests, related to interactions with their environment.

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Halyomorpha halys Stål (Hemiptera, Pentatomidae) is an invasive stink bug coming from Eastern Asia. Besides causing important yields losses in orchards, crop and vegetable fields, it overwinters inside houses as agglomerates of dozens. In the USA, this Brown Marmorated Stink Bug (BMSB) has been first observed in Pennsylvania. Fifteen years later, it is well established in 41 states. In Europe, BMSB was accidentally introduced in Switzerland in 2007 and has been later observed in surrounding countries (France, Italy, Germany). Based on the US situation, we can reasonably fear that BMSB will have colonized most of Europe countries in less than a decade. This stink bug is not recorded in EPPO quarantine lists, though.

According to our investigation on the interactions between stink bugs and their host plants, complementary behavioural and electrophysiological approaches were developed using BMSB. Also, comparative experiments with another non-native stink bug already well established in Europe, namely *Nezara viridula* L., were performed. After comparing the feeding and dispersion behaviours of both bugs, the impact of entomopathogenic fungi on bug behaviour was investigated. Our results will be discussed to present changes according to bug species, host plant and healthy/fungal infested status, in relation to potential biological control for these pests.

Keywords: Stink bugs, *Halyomorpha halys*, behaviour, entomopathogenic fungi

Invasive species insects on black locust (*Robinia pseudoacacia* L., 1753) in Belarus

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The black locust (*Robinia pseudoacacia* L., 1753) is a plant which has been introduced into Belarus. *R. pseudoacacia* is native to the Southeastern part of the United States. The culture in greenbelt black locust was used in the 1940s of XX century. These trees were actively used in the creation of shelter belts along roads and railway lines for the following years of 1950–60s. *R. pseudoacacia* is a popular decorative plant in Central and South regions of plant introduction in Belarus. The usage of black locust is not useful because the plants can badly withstand low temperatures in condition of North and North-Central regions. *R. pseudoacacia* began to penetrate into natural forests.

The black locust had been used effectively in the green stands before the end of the XX century, because of damaged plants only *Aphis craccivora* Koch, 1854. The complex species of herbivores penetrated in the second half of XX – beginning of XXI century in Belarus. Among them four phytophages *Nematus tibialis* Newman, 1837, *Obolodiplosis robiniae* (Haldeman, 1847), *Phyllonorycter robiniella* (Clemens, 1859) and *Parectopa robiniella* (Clemens, 1863), native to North America. These phytophages pose a threat to black locust stands in the case of mass reproduction.

O. robiniae, *N. tibialis* and *A. craccivora* encountered in all the areas growing *R. pseudoacacia*. *Ph. robiniella* is found in all the areas of the plant introduction in Belarus. *P. robiniella* concentrate on the Southern and Central regions.

Black locust loses decorative properties in the South of the country. This phenomenon is due to the mass reproduction of invasive pests. *A. craccivora* forms colonies on young twigs and seedpods, causing their withering. Aphids enter into symbiotic associations with ants (*Lasius niger* (L.), *Formica cinerea* Mayr). Invasive leaf miner damaging the leaf blade with the upper and lower sides. This is complex of invasive species can lead defoliation of plants before the end of vegetation period.

Keywords: black locust, *Nematus tibialis*, *Obolodiplosis robiniae*, *Parectopa robiniella*, *Phyllonorycter robiniella*, Belarus

Alien insects detected in Bulgaria during the period 2011-2015

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Nine plant feeding alien insect species have been detected in Bulgaria during the period 2011-2015 - *Deraecoris flavilinea* (A. Costa) (Simov et al. 2012); *Periphyllus californiensis* (Shinji) (Yovkova et al. 2013), *Corythucha arcuata* (Say) (Dobрева et al. 2013), *Drosophila suzukii* (Tomov, Ivanova 2014), *Phenacoccus peruvianus* Granara De Willink (Pencheva et al. 2014), *Cacyreus marshalli* (Butler) (Langourov, Simov 2014), *Aproceros leucopoda* Takeuchi (Doychev 2015) *Belonochilus numenius* (Say) (Aukema et al. 2013) and *Cydalima perspectalis* (Walker) (Beshkov et al. 2015).

In the framework of the project “East and South European Network for Invasive Alien Species – a tool to support the management of alien species in Bulgaria” (ESENIA-TOOLS), a survey was carried out to monitor their distribution and population status in Bulgaria. The environmental, social and economic impact of the species is analyzed and discussed.

References:

1. Aukema B, Rieger C, Rabitsch W (eds.) (2013) Catalogue of the Heteroptera of the Palaearctic Region. Vol. 6. The Netherlands Entomological Society, Amsterdam :1-629
2. Beshkov S, Abadjiev S, Dimitrov D (2015) *Cydalima perspectalis* (Walker, 1859) (Lep.: Pyraloidea: Crambidae: Spilomelinae) - New invasive pest moth in Bulgaria. Entomologist's Rec J Var: 127, 18-22
3. Dobрева M, Simov N, Georgiev G, Mirchev P, Georgieva M (2013) First Record of *Corythucha arcuata* (Say) (Heteroptera: Tingidae) on the Balkan Peninsula. Acta zool bulg 65 (3):409-412
4. Doychev D (2015) First record of the invasive Elm sawfly *Aproceros leucopoda* Takeuchi (Hymenoptera: Argidae) in Bulgaria. Silva Balcanica 16(1): 108-112
5. Langourov M, Simov N (2014) *Cacyreus marshalli* Butler, 1898 (Lep.: Lycaenidae), a new species for Bulgaria. Entomologist's Rec . Var 126: 190-192
6. Pencheva A, Yovkova M, Kozarov D (2014) Insect Pests on *Bougainvillea glabra* with description of *Phenacoccus peruvianus* Granara De Willink – A New Species in Bulgarian Greenhouses. Plant science LI 6: 90-93
7. Tomov R, Ivanova I (2015) Monitoring of exotic fruit fly species in Bulgaria. XVIII International Plant Protection Congress 24 – 27 August 2015, Berlin. Abstract book: 51-52
8. Yovkova M, Petrović-Obradović O, Tasheva-Terzieva E, Pencheva A (2013) Aphids (Hemiptera, Aphididae) on ornamental plants in greenhouses in Bulgaria. In: Popov A, Grozeva S, Simov N, Tasheva E (Eds) Advances in Hemipterology. ZooKeys 319: 347–361
9. Simov N, Langourov M, Grozeva S, Gradinarov D (2012) New and Interesting Records of Alien and Native True Bugs (Hem.: Heteroptera) from Bulgaria. Acta zool bulg 64 (3): 241-252

Keywords: Alien, insects, distribution, impact, ESENIA

Distribution of common ragweed (*Ambrosia artemisiifolia*) in ESENIAS area

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Common ragweed (*Ambrosia artemisiifolia*) is one of the most prominent invasive alien species (IAS) worldwide. South-central and south east European regions are the most affected. Its pollen grains are noxious aero-allergens, it is an important agricultural weed and also occupies large non-crop areas. ESENIAS (East and South European Network on Invasive Alien Species) was established in 2010 to create synergy on issues related to IAS among Balkans and the surrounding area. ESENIAS territory covers one of the most ragweed invaded areas – Pannonia, where the records of this species date back to early 20th century. Distribution data shows that after 1950 and especially 1990s, the introductions and spread of the species in the region increased. There are records from all ESENIAS countries although some of them are controversial like the results derived from Albania. In Turkey case, there was one and single record few years ago which comes in contrast with the fact of the higher pollen counts recorded in the last decade. In nowadays, records had been appeared in both parts of the country (European and Asian). Ragweed also has increasingly become a major weed in Balkan agriculture, especially in spring-sown crops such as sunflower, maize and sugar beet. It also invades pastures, marshlands, flood plains, roadsides, railroads and urban areas in the region. Furthermore, it has a population in a forest in western Black Sea Region of Turkey. Current situation suggests that not only Pannonia but also the whole ESENIAS area is under threat due to anthropogenic disruptions including climate change.

Keywords: Pannonia, Introduction, Spread, Impact, Balkans

Topic 07

Socioeconomic impacts of biological invasions

P-95

Cost-benefit and cost-effective analysis of managing invasive species in Mexico

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The cost of economic impacts of invasive alien species (IAS) has been estimated to be around 5% of the world's Gross Domestic Product (GDP). In Mexico, there are little or no data regarding these costs and, as the government faces the challenge of decreasing resources and competing budgetary priorities, stakeholders and decision makers are particularly interested in the efficacy and cost-effectiveness of various approaches to manage IAS. Despite this acute need, practitioners lack the specific skills to develop economic analyses focused on the costs of managing IAS. A training program was organized in 2015, to build capacities and undertake economic analyses of the impacts caused by invasive species in Mexico. This is being done under the guidance of experts of the Landcare Research Institute (LCRI). Projects are being carried out for high impact invasive and feral species such as *Tilapia cf. zillii*, *Pteryglichthys* sp and feral goats, among others. These studies are part of a series of training programs on economic analysis of managing IAS which LCRI has led in other regions. This training program is part of a GEF / UNDP financed project "Enhancing National Capacity of Mexico to manage invasive alien species by implementing the National Strategy on Invasive Species" coordinated by the National Commission for Knowledge and Use of Biodiversity (CONABIO) that will allow Mexico to have data to guide better decisions to deal with biological invasions.

Keywords: economic analyses, managing costs

A social-ecological study on the impacts and management of *Prosopis* (mesquite), one of the world's worst invasive tree taxa

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Prosopis (mesquite) is a conflict of interest invasive tree that has been introduced globally. Many *Prosopis* species were introduced to South Africa, have hybridised, and become the second most widespread invasive tree genus. These invasions have detrimental effects on biodiversity, ecosystem services and human livelihoods. However, there is still limited knowledge on the impacts, perceptions and management of *Prosopis* invasions. We used social-ecological studies to investigate the ecology, benefits and costs of *Prosopis* and develop a framework to guide the management of this tree. *Prosopis* was found to negatively impact local plant biodiversity across South Africa. Many social, economic and ecological impacts were raised by different communities including negative impacts on water, grazing, infrastructure and economic returns on farms and it was found that the relative direct use value of *Prosopis* in comparison to native trees was lower. This all provided evidence for the need for management as the costs outweigh the benefits of this conflict of interest tree. We then explore the barriers that are hindering the effective management and contrast differences between stakeholders. We then highlight strategic planning and prioritisation approaches to improve management in the future.

Keywords: Tree invasions, Management, Impacts, *Prosopis*, Barriers, Benefits, Costs, social-ecological

Topic 08

Restoration of invaded ecosystems

P-97

Fire differentially affects fitness and population growth of an invasive shrub compared to coexisting native species

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Fire is an environmental filter that selects for woody species able to survive or recruit and grow quickly in the post-fire environment. Those that survive fire maintain their location in the habitat, which is predicted to convey an advantage over recruiting from seed in fire-frequented habitats. Although resprouting is predicted to be advantageous, differences in mode of resprouting (i.e., resprouting from aerial or underground buds) should affect competitive interactions following fire and result in additional filtering. For those habitats that are invaded by exotic species, it is necessary to know the mode of regeneration after fire for native and invasive species, because this will predict whether the reintroduction of periodic fire will filter out invasives and successfully restore the native community. To determine the effects of restoration using fire on eight natives and one invasive native to Asia, *Lonicera maackii*, we reintroduced fire into fire-suppressed forests of central USA. Plots with coexisting native and invasive species were established during the summer of 2011 and burned or unburned during January 2012. Demographic measurements were taken during the summers of 2011-13, including growth, reproduction, survival, recruitment, and post-fire regeneration mode. We found that the invasive had significantly higher survival than any of the native species. It also had a different mode of post-fire regeneration; natives resprouted from root crowns and the invasive resprouted from aerial buds and were reproductive the first season following the burns. Although many of the natives were reproductive prior to burning, very few produced seeds in the first two years following fire. Seedlings of the natives and invasives were rarely observed after fire indicating that resprouting is the main regeneration mode for all species. Overall, burning had no significant effect on the population growth rate of the exotic, but negatively affects those of the natives. *Lonicera maackii* has been shown to outcompete native plants by blocking light attenuation; it grows quickly and spreads, allowing very little light to reach the forest floor. Burning may enhance this advantage because *L. maackii* is able to maintain its location in the shrub canopy while native species become restricted to the shrub understory. Fire acts as a filter that can quickly and dramatically alter the competitive balance between natives and invasives, and thus it should be used with caution unless post-fire regeneration modes and demographic responses are known in advance.

Keywords: competition, demography, fire, resprouters

Biotic resistance to invasive alien plants: Using a multi-trait approach to design resistant communities

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The invasion of alien species (IAS) contributes to ecosystem degradation, complicating efforts to restore degraded systems. Therefore, a key question arising is whether we can prevent the successful establishment of IAS during restoration by designing resistant plant communities. The theory of limiting similarity has been proposed as a tool for predicting biotic resistance of a target community to potential IAS. It states that IAS will be unlikely to establish if native species with similar traits are present in the resident community. However, most studies base trait similarity on single traits or broad classification of life forms. In this study we investigate whether we can predict biotic resistance by using a system of linear equations and a multiple-trait approach based on more specific functional traits related to competitive strength obtained from trait databases (see Laughlin 2014, *Ecol. Lett.* 17: 771-784). For doing so, a specific community was designed based on the trait similarity of grassland species native to central Europe and against each of two common IAS (*Ambrosia artemisiifolia* and *Solidago gigantea*). In a greenhouse experiment both specifically designed communities were separately tested against both IAS along with a control consisting on a monoculture of each IAS. Our results show that the community designed to repel *S. gigantea* was successful at suppressing both IAS, supported by the lower values of aboveground biomass found compared to the one designed to repel *A. artemisiifolia* and the control. A negative correlation between native and IAS aboveground biomass was only found for *A. artemisiifolia*. While these findings would suggest a partial support to the limiting similarity theory for *S. gigantea*, the suppression success of the same mixture on *A. artemisiifolia* indicates that other factors might better explain the suppression effect. That is, resistance seems to be related by either a biomass-driven suppression or the presence of particular highly competitive species, i.e. *Achillea millefolium*. Overall, our results indicate that species-specific effects can influence early stages of such artificial communities rather than limiting similarity. The lack of support could also be a consequence of failing to include really meaningful traits with respect to the most wanted functions of early development competitive suppression. Such can lead to the discussion if we have the right traits available in current trait databases.

Keywords: *Ambrosia artemisiifolia*; *Solidago gigantea*; Biotic resistance; Functional traits

Topic 09

Genetics and evolution of invasive species

P-99

Genetic evidence for the translocation of invasive bighead goby along rivers by commercial vessels

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In the marine sector, ballast water is widely acknowledged as a major cause of species translocations. The role of commercial shipping in the freshwater sector is much less well understood. Consequently, freshwater shipping and freshwater ballast tanks are not subject to any regulations aimed to minimize the spread of invasive species.

Using the example of the invasive bighead goby *Ponticola kessleri*, we will demonstrate the potential of shipping in the translocation of invasive freshwater fish. The bighead goby is a small benthic invasive fish from the Ponto-Caspian region that has colonized many European rivers. It is the forerunner of other, more prominent invasive goby species such as the round goby and the monkey goby. We analyzed 15 microsatellites in various bighead goby populations in Central Europe and compared the resulting population genetic patterns with ship travel and ship mooring patterns. In our talk, we will demonstrate how bighead goby genotypes mirror, both in the short range and in the long range, the travel behaviours of commercial vessels on the River Rhine. Furthermore, we will present evidence that freshwater cargo ships and tankers are plausible vectors for larvae of invasive goby species. We will explain why goby larvae are easily taken up with freshwater ballast water, and will demonstrate that attached Ponto-Caspian goby eggs survive both prolonged exposure to air and to water flow. In summary, we substantiate the paramount role of commercial shipping in freshwater fish translocations.

Keywords: Ponto-Caspian goby, population genetics, propagule transport, species translocation

Epigenetic mechanisms and the success of invasive vertebrates

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Invasive species are remarkably adaptive and deal exceptionally well with conditions they did not evolve for. Epigenetic pathways in their various flavors (DNA methylation, histone marks and a diverse array of RNA species) have the capacity to integrate environmental information, to persist in the germline, and to confer heritable and selectable phenotypes in offspring generations. This means that epigenetic mechanisms may promote the success of invasive organisms by promoting plasticity, short-term adaptations, and transgenerational inheritance of beneficial adaptations.

Despite massive progress in model organisms regarding the molecular mechanisms setting up and removing certain epigenetic marks, we understand very little about the role of epigenetic pathways in mediating adaptation processes of wild animal populations. To fill that gap, I have established the invasive round goby *Neogobius melanostomus* as a novel vertebrate model to study the interplay of epigenetics and adaptation in invasion success.

The invasive round goby is a benthic fish that has conquered fresh and brackish waters throughout Europe and North America. We sequenced and assembled its genome and have started to investigate the potential of maternal RNA to integrate external cues and transmit them to coming generations. We collected 1- to 16-cell embryos from the wild and sequenced maternal RNA. Ongoing analyses will reveal whether maternal RNA has the capacity to reflect environmental parameters experienced by the mother, such as temperature, light conditions, or oxygen content. Experiments on chromatin marks and DNA methylation have also been initiated and will reveal the potential of other epigenetic pathways to promote transgenerational adaptation in this novel wild vertebrate model species.

Keywords: Epigenetics, Invasion success, Adaptability

Colonization routes and genetic structure of common ragweed populations invading South-eastern Europe

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Common ragweed (*Ambrosia artemisiifolia* L.) is an annual herb mostly known as an invasive weed and an allergenic plant causing severe rhinitis. It has been introduced to Europe in the 19th century by the import of contaminated grain and forage. The most highly infested areas in Europe are the French Rhone valley and a large south-eastern area encompassing Hungary, Croatia, Bosnia, Serbia and part of Romania. *A. artemisiifolia* is expected to expand its range northwards due to climate change in the near future. However, expansion towards the south-east of the present range needs to be considered. During the last years, ragweed has dramatically expanded within cultivated areas (especially sunflower fields) in Turkey. Its presence is recorded eastwards up to Armenia. The aim of the present study was to understand colonization routes for ragweed occurring in the invaded range of south-east Europe. We used a set of recently developed microsatellite markers and a population genetics approach. The genetic diversity and genetic structure of populations sampled in Greece, Turkey and Armenia is described. To identify sources of colonization, these populations were compared with populations sampled throughout the European range in 12 countries (France, Italy, Germany, Poland, the Czech Republic, Austria, Croatia, Bosnia, Serbia, Hungary, Romania and Ukraine). We used a Bayesian approach as implemented in the software Structure to infer the presence of distinct genetic clusters and to assess whether populations sampled from south-east of Europe can be assigned a likely origin in the current invaded range of Europe.

Keywords: common ragweed, genetic structure, colonization routes, south-eastern Europe

Tracing the invasion pathways of the highly invasive box tree moth, *Cydalima perspectalis*, in Europe: a phylogeographic approach.

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Ornamental plant trade is a major pathway for alien phytophagous insects entering Europe, with an ever increasing number of these species originating from Asia. A notorious example is the box tree moth, *Cydalima perspectalis*, native to China, Korea and Japan, which was first recorded in 2007 in Europe. Since then, it quickly spread across Europe and to the Caucasus region. One decade after its first record in Germany, this defoliator pest is currently causing a lot of damage on ornamental and natural box (*Buxus*) plants in 27 countries. The trade of ornamental box plants between Europe and China has been hypothesized as the invasion pathway of the insect while the trade between European countries could explain its fast expansion. To disentangle the invasive pathways of the box tree moth, samples of *C. perspectalis* were collected in the native range of China and Korea and so far in 17 invaded countries of Europe. A portion of the mitochondrial genes Cytochrome Oxidase I and II has been sequenced from individuals of native and invaded areas. This preliminary analysis revealed a total of 8 haplotypes in the native region. Among them, 7 were observed in China and 2 in Korea (with one shared with China). In Europe 4 haplotypes, of which 2 being mostly represented, were found so far in the invasive populations sampled. Though preliminary, our results suggest a Chinese origin supported by the fact that all these haplotypes were also found in China. However, the low number of Asiatic samples already analyzed coupled with the lack of genetic structure in the native range, did not yet allow to define precisely the potential donor regions. The genetic diversity observed in Europe also suggests multiple introductions events for the box tree moth. Nevertheless, a wider sampling in the native area in concert with the application of microsatellite markers will help to better understand the invasion pathways of this pest as well as its rapid spread into Europe.

Keywords: Invasion, Insect, *Cydalima perspectalis*, Ornamental plant trade, *Buxus*, Phylogeography, Multiple Introductions

***Brachycaudus divaricatae* Shap. (Sternorrhyncha, Aphididae) in Belarus: genetic divergence from Armenian aboriginal forms**Nina Voronova, Maryia Varabyova, [Sergey Buga](#)*Belarusian State University, Minsk, Belarus*

Brachycaudus divaricatae Shaposhnikov, 1956 is an invasive aphid species, which has been dramatically spread across the territory of Belarus within a decade. This species of aphids was described in the middle of XX century from Transcaucasia and the neighboring regions of Near East and Central Asia, which is considered to be its primary area. In 2002 *B. divaricatae* entered the territory of Lithuania and Poland, and was first registered in Belarus in 2008. At present *B. divaricatae* became widespread across all the territory of Belarus causing significant damage to cherry plum (*Prunus divaricate* Ledeb.) in gardens and green areas.

When exploring mechanisms that provide aphids with the high level of ecological plasticity, the most intriguing question is: whether this dramatic expansion to the new territories is accompanied by the substantial changes in the genetic variability, which can be both: the increasing of the level of genetic heterogeneity of invaders owing to the high level of natural selection or extreme reduction in the number of genetic variants due to the founder effect. We have studied the level of genetic heterogeneity of invasive populations of *B. divaricatae* in Belarus versus aboriginal forms of this species from Armenia.

We have identified three haplotypes of COI gene in Europe so far and all of them were found in both Belarus and Armenia. Despite the high conservatism of COI genes in aphids there were two nucleotide and one amino acid substitutions. This level of genetic variability of COI gene corresponded well with the conventional degree of the intraspecies variability of COI gene in aphids.

Analyses of 11 microsatellite loci with low number of alleles showed that there were individuals with unique STR-alleles in populations of *B. divaricatae* from Belarus and Armenia. In general, the level of variability of STR loci was low in both populations, but *B. divaricatae* from Belarus were slightly less variable comparing to Armenian ones. At the same time, we did not find any substantial differences in the STR patterns between aphids from Armenia and Belarus in spite of being dramatically remoted. We did not observe any signs of manifestation of founder effect. As a result of phylogenetic analysis of all 11 STR loci we could assume that *B. divaricatae* had permeated into the territory of Belarus more than once and formed several genetic lines by now, which slightly differ in the STR patterns.

Considering our study, we could summarize that expansion of *B. divaricatae* into new territory occurs without significant loss of genetic variability.

Keywords: *Brachycaudus divaricatae*, aphids, genetic variability, invasive species, cherry-plum aphid, microsatellite loci, STR analysis

P-104

What makes invasive *Ageratina adenophora* successful in Western Himalaya: Contemporary evolution or phenotypic plasticity?

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Mountains have been considered relatively immune to invasive plants, but recent studies have indicated that increasing number of invasive plants have scaled new heights along elevational gradient across the globe. The process of invasion along an elevational gradient offers the opportunity to study the mechanisms that lead to its success. After initial establishment and colonization, invasive plants undergo rapid range expansion in the invaded range which often involves spanning steep abiotic gradients in order and become a successful in diverse conditions. Rapid evolutionary processes and phenotypic plasticity are believed to be contrasting but not mutually exclusive mechanisms leading to naturalization and spread of invasive plants in new biogeographic areas. To understand some of the processes that lead to successful invasion and range expansion, we choose to study the populations of noxious plant invader *Ageratina adenophora* in western Himalaya along an elevational gradient of 1700m. We used a reciprocal transplant design with three common gardens and 15 populations originating from three elevational levels to investigate the relative role played by rapid evolutionary processes and phenotypic plasticity. We measured a suit of different traits related to germination, performance, fitness and phenology. Our results showed lack of local adaptation and population differentiation for all the traits that we measured but the trait values differed significantly between the gardens except for leaf functional traits, which indicated high degree of phenotypic plasticity of this invasive species for most of the traits. Possible causes such as gene flow, triploidy, apomixes and preadaptation might have confounded evolutionary processes to act upon. In a broader context, we tried to explain the observed humped shaped pattern of abundance along the elevational gradient in context of our experimental results. Finally, we assessed how well Bakers concept of ideal weed fits *Ageratina adenophora*.

Keywords: Invasive Plants, Crofton Weed, Local adaptation, Phenotypic Plasticity, Clinal differentiation, population differentiation, preadaptation, apomixis,

Does experimental manipulation of epigenetic variance in DNA methylation affect local adaptation? - A reciprocal transplant experiment comparing native and non-native ruderal plant species

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Epigenetic variation has recently gained attention as potentially contributing to local adaptation in plants, and as facilitating rapid adaptation of non-native plants in their introduced range. However, its mechanism is still poorly understood. Heritable modifications of phenotypic traits via epigenetic variation in DNA methylations have been previously described in plants, and plant individuals from a given location can show specific patterns of DNA methylation when compared to individuals from other locations. Since non-native plants often start as small populations in the introduced range and therefore lack genetic variation, epigenetic variation might be important as an alternative mechanism leading to phenotypic differentiation. Hence, one could hypothesize that epigenetic variation would contribute more to local adaptation in non-native plant species than it does in native plant species. To test this, we will conduct a reciprocal transplant experiment including multiple pairs of non-native and co-occurring native confamilial ruderal plant species. In each of two common gardens (one in northern Germany, one in southern Germany, with contrasting climatic conditions), we will grow plants from seeds collected in both locations, after manipulating the extent of epigenetic variation by treating half of the plant seedlings with a de-methylation agent (zebularine). The plants will be directly planted into soil at ruderal sites, i.e. under natural environmental conditions. During the experiment, we will measure performance and phenological traits. This study aims at extending the findings of previous studies to a broader range of non-native plant species.

Keywords: Epigenetic variation, reciprocal transplant experiment, local adaptation, non-native ruderal species, native ruderal species, DNA methylation

Pollen of common ragweed (*Ambrosia artemisiifolia* L.): Illumina-based de novo sequencing and differential transcript expression upon elevated NO₂/O₃

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Background:

Common ragweed (*Ambrosia artemisiifolia* L.) is a highly allergenic annual ruderal plant and native to Northern America, but now also spreading across Europe. Air pollutions and climate change will not only affect plant growth, pollen production and duration of the whole pollen season, but also the amount of allergenic encoding transcripts and proteins of the pollen.

The objective of this study was to get a better understanding of transcriptional changes in ragweed pollen upon NO₂ and O₃ fumigation. This will also contribute to a systems biology approach to understand the reaction of the allergenic pollen to air pollutions and climate change.

Results:

Ragweed plants were grown in climate chambers under controlled conditions and fumigated with 40 ppb NO₂ (control) and 80 ppb NO₂ (treatment). The experiment was repeated using clean air (control) and 80 ppb NO₂ (treatment). In the other setup plants were fumigated with 40 ppb O₃ (control) and 80 ppb O₃ or 120 ppb O₃ (treatment). Illumina sequencing and de novo assembly revealed differentially expressed transcripts, belonging to different gene ontology (GO) terms that were grouped into biological process and molecular function. Transcript levels of the known ragweed encoding allergens were clearly up-regulated under elevated NO₂, whereas the amount of allergen encoding transcripts was more variable under elevated O₃ conditions.

Conclusions:

The transcriptional changes in ragweed pollen upon elevated NO₂ fumigation indicates that air pollutions will alter the transcriptome of the pollen. The changed levels of allergenic encoding transcripts may have an influence on the total allergenic potential of ragweed pollen.

Keywords: *Ambrosia artemisiifolia*, Allergen, NO₂, O₃, Pollen, Ragweed, Transcriptome

Characterization of a novel allergen from ragweed (*Ambrosia artemisiifolia* L.), enolase Amb a 12, with high homology to Hev b 9 from rubber tree

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Background: Ragweed pollen is the main cause of respiratory allergic diseases in Northern America and the weed has become a spreading neophyte in Europe. The spectrum of allergens in ragweed pollen has been characterised, and different allergenic proteins consisting of different isoforms have been characterised (Amb a 1 – Amb a 11). The major allergen of ragweed is Amb a 1, an acidic 38-kDa proteins that belongs to the pectate lyases. Recently a putative new allergen from ragweed with homology to Hev b 9, an enolase, from para rubber tree was described. We now verify and characterize this putative new allergen from ragweed pollen.

Results: PCR cloning and expression in *E. coli* resulted in two full length cDNA clones of this novel allergen from ragweed. Sequencing showed high homologies to known enolases. The recombinant expressed proteins, termed rAmb a 12.1 (431 amino acids) and rAmb a 12.2 (445 amino acids) were purified and characterized by LC-MS/MS and intensive immunoblotting. Enolase enzymatic activities confirmed this new allergen. Phylogenetic tree analysis showed the nearest relationship to an enolase from *Glycine max*. Three-dimensional modelling showed a high structural homology to known human enolase. Natural Amb a 12 was also isolated from ragweed pollen and fully characterized by LC-MS/MS, as well as intensive immunoblotting. The capacity to activate basophils from patients with ragweed allergy was confirmed for rAmb a 12, as well as nAmb a12. This indicates that post translational modification is not required for IgE binding.

Conclusion: We identified and characterized an enolase as a novel minor allergen from ragweed pollen, which has been designated as Amb a 12.

Keywords: *Ambrosia artemisiifolia*, allergen, Amb a 12, enolase, proteome, ragweed

***Oxalis corniculata*: around the world and back again**

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Oxalis corniculata is perhaps the most ubiquitous of horticultural weeds, it has been found in every country and is frequently transported with horticultural products. The ancestors of this group are South American (Vaio et al., 2014, Mol. Phylogenet. Evol. 68: 199–211). Yet, little else is known of its origins and how it became so well dispersed. It belongs to section Corniculatae of the genus, which also contains several other weedy and invasive species. We have examined the phylogenetics, taxonomy and phytogeography of section Corniculatae to explain its distribution. Furthermore, we have examined historical accounts, particularly in Europe, to understand the role of people in its dispersal. Section Corniculatae can be divided into two groups, both of which have invasive members, one containing *O. corniculata* s.s. and the other containing *O. stricta* s.s. The corniculata group seems to have crossed the Pacific to Asia or Australasia. While the stricta group evolved in North-America and migrated eastward. In Australasia species radiation occurred forming at least six closely related taxa. These *Oxalis* species spread from Australasia and North-America both naturally and under the influence of humans. For example, *Oxalis exilis* was dispersed from Australasia entirely by the horticultural industry and by plant collectors. Weedy North-American species *O. stricta* and *O. dillenii* evolved in North-America after their ancestor migrated naturally from South-America. They were spread eastward into Europe and then further by humans. Though the ancestors of the section Corniculatae group left South-America naturally their kin travelled both eastward and westward to eventually return to South-America as introduced weeds.

Keywords: biogeography, phylogenetics, dispersal

Impacts of the invasive tree *Robinia pseudacacia* across trophic levels: small effects on species richness, but great differences in functional species traitsJiří Reif¹, Martin Hejda², Jan Hanzelka¹, Tomáš Kadlec³, Martin Štrobl³, Petr Pyšek^{2,4}¹*Institute for Environmental Studies, Charles University in Prague, Faculty of Science, Benátská 12, 128 01 Prague 2, Czech Republic, Prague, Czech Republic*²*Department of Invasion Ecology, Botanical Institute, Czech Academy of Sciences, Zámek 1, Pruhonice 252 43, Czech Republic, Pruhonice, Czech Republic*³*Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Kamýcká 129, 165 21 Prague, Czech Republic, Prague, Czech Republic*⁴*Department of Ecology, Science Faculty of the Charles University, Vinická 7, Prague, Czech Republic, Prague, Czech Republic*

Invasive trees are often presumed to have a severe, large-scale impacts on the invaded community. However, there is a lack of data providing such complex insights. Therefore, we sampled 39 large, one hectare plots and recorded species of vascular plants, nocturnal Lepidoptera and birds. Nineteen plots with a high dominance of *R. pseudacacia* were compared to analogous 20 plots with native trees and with similar environmental conditions. Species richness was compared using marginal GLMs between the invaded and native stands and the species composition as well as the distribution of species' functional groups was investigated by direct gradient ordination analyses. The analyses revealed only minor differences in species richness between the two types of stands for vascular plants and birds; but the invaded stands hosted significantly lower numbers of species of nocturnal Lepidoptera. In case of vascular plants, the non-significant result is likely to be caused by large residual variability, since both the invaded and native stands included plots with very high and, on the contrary, very low numbers of species. All three groups of target species revealed significant differences in species composition between the invaded and native stands, with nitrophilous and hemerobic plants preferring the invaded stands and habitat-specialist birds preferring the native. Nocturnal Lepidoptera reveal a partially contrasting pattern, with species of open habitats preferring the invaded stands, whereas canopy species and habitat generalists prefer the native stands. These preliminary results suggest that the invasion of *R. pseudacacia* may not reduce the diversity of species per se, however, it can result in profound changes in species composition of invaded communities and replacement of forest species by weeds in case of plants, habitat-generalists in case of birds and the absence of canopy herbivores in case of insects.

Keywords: *Robinia pseudacacia*, invasive trees, impact, diversity, native species, plants, moth, birds, ecosystem-level approach

The role of epigenetic inheritance in rapid evolutionary adaptation of two invasive *Solidago* species

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Many invasive plant species have become phenotypically differentiated within their invaded range, particularly along latitudinal clines, in many cases reflecting local adaptation. However, as invasions usually start from small populations with limited genetic variation, the mechanism of rapid adaptation in invasive organisms is still poorly understood. Only recently have epigenetic variation and inheritance gained attention as a possible mechanism contributing to rapid adaptation. Although the contribution of this form of inheritance is still unknown in many species, it has the potential to facilitate plant adaptation to new environments despite limited genetic variability, as might be the case in invasive species. In a common garden experiment, we tested whether epigenetic inheritance is a potential contributor to local adaptation in the two invasive plant species *Solidago canadensis* and *S. gigantea* using seed material of populations collected along a latitudinal gradient in Central Europe (46° to 60° north). Half of the seedlings were experimentally manipulated with the de-methylation agent zebularine, and plants were grown in one common garden in the north and one common garden in the south of Germany. In de-methylated and control plants of the same maternal origin per population, we measured flowering phenology and several performance-related traits as proxies of plant fitness. For both species, first analyses indicate latitudinal clines in phenology and several performance-related traits. Contrary to expectations, these clines were not always inverted between the northern and southern common gardens, suggesting other factors than local adaptation as drivers of these latitudinal patterns. While zebularine treatment appears to have modified clines of performance-related traits in some instances, the modification is not in a particular direction. This suggests that the latitudinal clines are not caused by epigenetic mechanisms.

Keywords: invasive plant species, local adaptation, epigenetic inheritance, DNA methylation, *Solidago canadensis*, *Solidago gigantea*, latitudinal gradient, common garden experiment

Evidence of local adaptation to high UVB levels in the invaded range? A multi-species approach with native and exotic origins of introduced species in New Zealand

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Ultraviolet B radiation levels fundamentally differ between hemispheres, with much higher levels in the southern hemisphere, and may act as an environmental filter, which might particularly apply for non-indigenous plant species from Europe in New Zealand. Just as for any abiotic or biotic filter, successful invaders can cope with novel environmental conditions via plastic responses or through rapid adaptation to local selection factors in the invaded range. Multi-species comparisons and within-species comparisons of native and exotic origins in reciprocal common garden situations are necessary to assess the relative importance of both processes.

We conducted a multi-species experiment with herbaceous species in two common gardens located each in the native and the invaded range. In Germany and New Zealand, respectively, we applied a within-species approach including native (German) and exotic (New Zealand) origins of eight species to test for adaptive evolution to higher UVB radiation in the invaded range. In each common garden, all plants were exposed to three radiation treatments: (i) natural sunlight, (ii) exclusion of UVB while allowing natural UVA, and (iii) exclusion of both UVB and UVA.

A linear mixed-effect model showed an overall limiting effect of UVB on growth and productivity, such as leaf length and plant expansion, in both common gardens. While exotic species with a broad niche in response to UVB radiation seem to be able to cope with higher UVB levels in New Zealand via plastic responses, the outcome of the within-species approach points at recent evolutionary processes to be of importance: Consistently for both common garden experiments, the respective ‘away origin’ (i.e. native origin in the invaded range, exotic origin in the native range) displayed stronger differences in growth between the UV treatments, whereas the ‘home origin’ showed no such differences among UV levels. This suggests an increased UVB sensitivity of plants away from their home range possibly enhanced by the cost of adaptation to the novel environment. In the northern hemisphere common garden, the native origins resulted in a higher aboveground biomass, leaf length and expansion. No such origin effect was observed in the southern hemisphere common garden, i.e. we found no evidence for better UVB adaptation of exotic individuals. Nevertheless, this result indicates rapid evolution of species in the invaded range, resulting in maladapted exotic genotypes when being retransferred in the native range.

Keywords: Germany, hemispheres, local adaptation, multi-species experiment, New Zealand, plasticity, reciprocal common garden, UVB radiation, within-species approach

P-112

Rapid adaptation speeds spread and increases densities in experimental invasions

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What role does evolution play in driving invasions? Clearly, introduced populations of species evolve, both due to the genetic vagaries of the introduction process, and via adaptation to their novel environment. It is less certain, however, the degree to which evolutionary changes in introduced populations are drivers of invasions versus by-products of a species encountering a novel environment. We addressed this issue with experimental invasions of the model species *Tribolium castaneum*. We introduced 20 individuals into replicate experimental landscapes with a novel food source. We allowed some replicate populations to evolve without interference, and while we replacing individuals one-for-one each generation in other replicates. This maintained demographic processes, while preventing adaptation and minimizing genetic drift. We find that evolving populations grew 4 times larger than non-evolving ones in only 6 generations. A test in a common environment shows this large difference is driven by adaptation to the novel environment. Furthermore, evolving populations spread faster. Spread was likely driven by higher densities, but there is also some evidence that the dispersal ability itself may have evolved. These results show clearly that evolution is not a passenger in the process of biological invasions, but is a crucial player in determining their outcomes.

Keywords: evolution, adaptation, gene surfing, *Tribolium*, mesocosm

Genome size and invasiveness traits in the hybrid meadow knapweed complex (*Centaurea x moncktonii*) in eastern North America

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Hybridization and genomic admixture between divergent populations or species may be an important driver of plant invasiveness. Recent studies have emphasized the critical role that reductions in genome size may play in facilitating the rapid evolution of invasiveness, and small genome size has been associated in some plant invaders with increased competitive ability and reproductive effort. Here, we report on genome size and trait variation in a hybrid complex of knapweeds (genus *Centaurea*) invasive in eastern North America. The hybridizing swarm consists of extensive introgression between brown knapweed (*C. jacea*), black knapweed (*C. nigra*) and their hybrid (*C. x moncktonii*). Previous studies of this complex in Europe have reported both diploid ($2n = 22$) and tetraploid ($2n=44$) cytotypes, with extensive genome size polymorphism observed among populations. We sampled seed from 10 maternal plants from each of 20 populations located across two regions (New York and Vermont). Six seed offspring per maternal family were germinated and grown in a greenhouse to maturity. Individuals were measured for traits associated with invasiveness based on vegetative size and competitive ability (maximum height, specific leaf area, total biomass) and reproductive effort (time to flowering, flower and capitula number). Leaf tissue was sampled from a subset of 2-4 offspring per family for genome size analysis by flow cytometry. The mean 1C value of genome size was 1.92 pg, with a coefficient of variation of 2.2%, consistent with the presence of exclusively tetraploid cytotypes in our sample. There was significant geographic structure to genome size at both the among-region ($p=0.01$) and among-population ($p<0.0001$) scales. Invasiveness traits also varied among populations; however, we observed no association between genome size and trait variation. The results suggest significant variability in this invasive hybrid swarm for genome size, probably arising from non-homologous crossing over among introduced tetraploid cytotypes, but this variation does not translate directly into differences in functional traits predictive of plant invasiveness.

Keywords: hybridization, admixture, genome size, introgression, plant functional traits, knapweed, *Centaurea*

Tropical Guests in Semi-Arid Regions of Turkey: Local Adaptations or Evolutionary Changes?

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Invasive plants undergo adaptive and evolutionary changes in non-native habitats for a successful establishment. Increased incidences of two tropical ground cherry species (*Physalis angulata* L. and *Physalis philadelphica* Lam. var. *immaculate* Waterfall) have been reported in the irrigated field crops of semi-arid regions in Turkey. As both weeds are native to tropical regions, their presence in a semi-arid region makes them subject of great interest. We hypothesized that both weeds have undergone local adaptations which helped them to establish and spread in the region. The seedling establishment, growth, nutrient uptake and reproductive output of both weeds have been tested under 5 water stress (100, 75, 50, 25 and 12.5% pot water contents) and 4 salinity treatments (0, 3, 6, 12 dSm⁻¹) in a manipulative greenhouse experiment. Both weeds successfully tolerated to all watering and salinity treatments with slight seedling mortalities. The seedling mortality was observed only under extreme water and salinity stresses. The growth performances (plant height, biomass production and growth rate) of both weeds were negatively affected with increasing severity of water and salinity stresses. However, tested weeds differed for tolerance strategies against abiotic stresses. *P. angulata* showed a higher tolerance to water stress while *P. philadelphica* survived better under high salinity stress. Higher nutrient acquisition and maintenance of better K/Na ratio were noted in *P. philadelphica* compared with *P. angulata*. Similarly, *P. philadelphica* produced more number of seeds per plant in comparison to *P. angulata* under all experimental conditions. We concluded that both weeds have higher adaptive potentials to the increasing aridity and salinity conditions. We also observed that higher uptake of K and lower Na with increasing salinity in *P. philadelphica* can be related to the mechanism of salinity tolerance. Results indicated that further expansion of both weeds can present severe challenges for crop production in the semi-arid regions of Turkey. However, evolutionary changes in both weeds with changing environmental conditions need to be explored for reaching a solid conclusion regarding their adaptations to the semi-arid environmental conditions.

(This study was funded by TUBITAK with grant number 113 O 790 as a part of Cost Action TD-1209)

Keywords: Ground cherry, *Physalis angulata*, *Physalis philadelphica*, water stress, salinity, local adaptations

***Solidago x niedereideri* (*S. canadensis* x *S. virgaurea* ssp. *virgaurea*) in the Eastern Alps**

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The hybrid of the European *Solidago virgaurea* ssp. *virgaurea* and the North American *Solidago canadensis* was described in Upper Austria by Khek in 1905. Additional Austrian findings followed from several provinces (Speta 1974, Polatschek 1978, 1997, Melzer 1984 and Leute 1986). Findings outside Austria are documented from different regions, amongst others Great Britain, Scandinavia or Poland (see Plizko 2013). Usually it is considered to be a rare and occasionally occurring hybrid.

Field studies in the Eastern Alps during the last 10 years show a clearly different situation. In North Tyrol where both parents are very common and *Solidago canadensis* is the most invasive alien species (Pagitz 2008) the hybrid is also frequent (Pagitz & Lechner Pagitz 2015). Additional field studies in East Tyrol, Carinthia (Austria) and South Tyrol (Italy) confirm the results.

Both parental taxa and the hybrid are diploid. Khek described *S. x niedereideri* with intermediate characters. Detailed analysis of Austrian and Italian plants in 2012 confirm Khek. Almost all morphological characters from the habit to the fruits are intermediate. Furthermore, all individuals collected in the wild (2011) gave rather uniform measurements. This makes it easy to recognize the hybrid in the field. Morphological based determination is supported by genetic analysis.

Tests on the fertility of the hybrid in 2012 show a germination rate of optically pre-selected fruits of 31%. In the second year almost all were fruiting. Morphological measurements in 2014-15 of individuals of the second generation show a bit more variability. Visual checks gave an amount of 63% intact fruits. Furthermore, some flowering stems have been covered by a fine-meshed net to keep insects away with the result of only 17% intact fruits. This gives evidence to reduced self-fertility of the hybrid caused by self-incompatibility or a reduced number of fertile pollen (see Plizko 2013) and at the same moment it underlines the possibility of cross pollination.

Conclusion: *Solidago x niedereideri* is common in the Eastern Alps. The presumably F-1 generation shows good fertility, also with a high number of intact fruits in the F-2 generation. Seeds are usually produced by cross-pollination, whereas self-pollination is of minor importance. This promotes backcrossing and introgression.

Keywords: *Solidago*, hybrid, Austria, Alps, Tyrol

P-116

Genetic differentiation of native and introduced populations of *Quercus rubra* L.

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Native to North America, Northern red oak (*Quercus rubra*) was introduced in Europe in the XVIIth century for ornamental and forestry purposes. This species is now widespread in European forests due to plantations and natural regeneration. In invasive herbaceous plants, introduced populations are often genetically different from native populations. However, this has been poorly investigated in exotic tree species. Our objective was to explore the phenotypic variation between native and introduced populations of *Q. rubra* and to test for adaptation to the new environmental conditions since the introduction.

We used three progeny test gardens, in South-Western, Central and North-Eastern France, composed of 106 American and European populations with 1-25 families per population. The gardens were settled from 1980s and trees were monitored regularly for growth (diameter, height) and leaf phenology (budburst, coloration). Since trees had reached sexual maturity, we have monitored acorn production for two years. Within each garden, data were analyzed using mixed analyses of variance; Qst indexes were calculated to evaluate genetic differentiation between populations.

Overall, introduced populations presented higher trait values than native populations: growth rate was higher and spring phenology was advanced. Fruit set was higher in introduced trees, although depending of the year. Qst estimates clearly demonstrated the existence of a high genetic differentiation between native populations, for growth and phenology. Introduced populations presented a lower level of differentiation than native populations.

These results suggest several hypotheses: (i) introduced populations only represent a part of the global diversity existing in the native range (ii) populations have evolved since introduction under new environmental selective pressures (ii) populations were selected by man since introduction. These hypotheses are being investigated, notably through a molecular approach.

Keywords: invasive tree, population diversity, quantitative genetics

Postglacial colonizer or cryptic invader? Case of *Gammarus roeselii* (Crustacea Amphipoda) in Europe

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Gammarus roeselii Gervais, 1835 is an epigeic species commonly found in rivers and lakes of Europe. The species is easy to tell apart from most other local species of *Gammarus* by presence of large dorsal spines on the metasome part of the body. Its range expands from France and Netherlands on the west, to Poland on the east and Greece on the south. The species is suspected to be of Balkan origin and to colonise the more northern regions of Europe in historical times.

In our study we aimed to test this hypothesis i.e. to define the origin of populations from western and central Europe and to reveal whether these populations fit the model of demographic/spatial expansion. We amplified a 533 bp long portion of the mitochondrial cytochrome oxidase I (COI) marker from 537 specimens collected from 65 locations all over Europe, including 26 locations from the Balkan Peninsula. Neighbor-Joining phylogram was produced in Mega 6 for basic reconstruction of phylogeny. Relationships between haplotypes in populations from the presumably newly colonized part of Europe were illustrated with Minimum Spanning Network (MSN) constructed in PopART. Mismatch Distribution (MD) analysis with Tajima's D, Fu's F and Harpending's raggedness indices calculated in Arlequin were used to assess demographic state in these populations. Demographic changes in time were plotted using Bayesian Skyline (BSP) analysis in BEAST. Our results witness that populations of *G. roeselii* occurring in western and central Europe derive from the northernmost part of the Balkan Peninsula and from the Pannonian Plain i.e. from the Danube catchment (Black Sea basin). MSN revealed existence of two haplotype groups widely spread in western and central Europe. The obtained star-like topology of MSN for these two groups as well as results of the MD analysis and neutrality tests suggest that western and central European populations of *G. roeselii* are in the state of both demographic and spatial expansion. BSP shows that the demographic expansion have started at ca. 10 kya and accelerated at ca. 6 kya for one haplotype group and at ca. 2 kya for the other one. Thus, we may suspect that, already in early Holocene, the species has started its colonization up the Danube system. On the other side, its current distribution suggests that the species crossed the main watersheds only after large navigable canals were built and joined the Black, Mediterranean, North and Baltic Sea basins.

Keywords: phylogeography, gammarids, invasive species, Europe, Balkan Peninsula

Topic 10

Engaging the public with the topic on invasive species

P-118

Alien vertebrate pets and ornamental outdoor and aquarium plants with commercial value in the Spanish peninsular territory as potential invasive species.

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Transport of alien species may be deliberate or accidental. The commercial uses of alien species for recreational or ornamental uses, such as pets or plants for gardens and aquariums, are main pathways for deliberate introduction.

We compiled a database which includes the vast majority of alien vertebrate pets and ornamental outdoor and aquarium plants with commercial value in the Spanish peninsular territory. We classified them according to its invasive status in Spain, including if regulated and also according to its invasive and regulatory status in other countries, its climatic suitability for Spain and potential ecological and socio-economic impacts. Overall, the database includes more than 1000 plant and more than 600 vertebrate species. This database will be transferred to the regional and national authorities as the bases for Horizon scanning on potential invasive species in Spain which introduction could be avoided.

Keywords: Pets, Garden plants, Alien invasion, Ornamental species, Horizon scanning, Potential invasive,

P-119

Engaging general public in invasive alien species observation: Citizen Science in Mexico

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To increase awareness about biological invasions while engaging the broader public the National Commission for the Knowledge and Use of Biodiversity (CONABIO), in collaboration with INaturalist, developed a citizen science program; the platform NaturaLista in Spanish, to gather information on Mexican biodiversity. The platform has received a large and growing public acceptance, mainly for its role as a social network. Users can upload their observations of plants, animals and fungi, through images (photographs mainly and video) or audio, to be shared with, and identified or verified by, the community. This allows CONABIO to gather updated information on presence and distribution of species. In order to engage the nature observer community, in 2015, a prize was given to the most active members of the platform. We have added two ‘projects’ focused on invasive species, in order to help map current distribution of exotic species and to detect new arrivals. The projects have been successful as in two years we have detected three previously unreported species (for example *Chicorus circumdatus*, *Streptopelia roseogrisea* and *Bipalium kewense*), and have over 2300 records from citizens from all over the country. We also have been able to confirm the expansion of the red eared slider *Trachemys scripta* released from the pet trade in urban areas.

Keywords: citizen science program, platform NaturaLista, IAS identification

P-120

Introduced species of spiders and harvestmen in Luxembourg

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Just like in other groups species of spiders and harvestman have reached regions in which they did not occur before. Naturally, the Grand Duchy of Luxembourg does not escape this phenomenon.

The aim of this poster is to list the known introduced spider and harvestman species. All of them have been recently evaluated for an environmental impact assessment and classified after the ISEIA Protocol. The resulted indices are given. Further two species, one per group, with a certain perception of the great public are presented.

Keywords: Luxembourg, Arachnida, Araneae, Opiliones, spiders, harvestman

P-121

Utilising gardeners' knowledge to prevent plant invasions from ornamental horticulture

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Most non-native plants including the plants with the highest negative impacts have been introduced as ornamental plants. Long delays from the introduction in a garden to the recognition of a problematic invasive plant in the wild make effective control strategies very difficult and often impossible. Gardeners will notice first if ornamental plants show characteristics, e.g. vigorous growth, spread and difficulty to control, that may contribute to their potential to become a problematic invader. This project tests if the reporting of early warning signs from gardens could help to design more effective prevention strategies at the first stages of the invasion process. An online reporting form was developed and botanists and professional gardeners in Britain were asked to report ornamental plants that are spreading and difficult to control in their gardens. The survey also included questions on how the ornamental plants reported had come into participants' gardens, their management, and where new plants were sourced from.

Results show that the most frequent plants reported are also frequently recorded outside cultivation. However, the list of reported plants also includes species with a recently increasing distribution and species not reported outside cultivation. The results provide evidence that gardeners' knowledge could help to identify potentially problematic invasive plants early in the invasion process. The main obstacle for the expansion of the approach to the wider gardening public is the potential difficulty with plant identification. At the same time, however, raising awareness for the problem by actively involving gardeners could be of equal importance for the prevention of ornamental plant invasions.

Keywords: ornamental plants, citizen science, online survey, Britain

A network of invasion hypotheses: well-known hypotheses are not well connected

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Invasion biology is a thriving ecological research field, and confusingly many hypotheses, concepts and ideas about biological invasions populate today's literature. Moreover, some of these hypotheses are very similar, whereas others contradict each other. A helpful tool for invasion biology would thus be a network of invasion hypotheses that visualizes these similarities and dissimilarities between major hypotheses. Such a network would help everyone interested in invasion biology to better understand this field's theory and conceptual structure. To create a hypotheses network, we developed an online questionnaire, asking experts in the field about similarities and dissimilarities between 33 common invasion hypotheses. We defined each hypothesis and provided the definition in the questionnaire. In the resulting hypotheses network, highly connected hypotheses have a high degree of similarity with many other hypotheses, and contradictions between hypotheses are highlighted as well. We also show which invasion hypotheses were best known by the 357 researchers answering the questionnaire. Interestingly, the best-known hypotheses (enemy release, propagule pressure, disturbance) were not the ones with most connections in the network (new associations, island susceptibility and opportunity windows). This surprising result calls for more research about invasion hypotheses at a meta-level.

Keywords: Biological invasions, Concepts, Defining invasion hypotheses, Hypotheses network, Invasive alien species

Current Status of Two Invasive *Physalis* Species in Turkey

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The occurrence of two tropical ground cherry species (*Physalis angulata* L. and *Physalis philadelphica* Lam. var. *immaculate* Waterfall) has increasingly been reported in irrigated areas of South Eastern Anatolia (SEA) in Turkey. Therefore, this study was conducted to record the current distribution of the plants in Turkey. Extensive surveys were conducted in SEA, Black Sea and Marmara regions of the Turkey. The data relating to the presence/absence, accompanying vegetation, ecology and soil properties were also noted. Soil samples were collected from each surveyed site and some of physical and chemical characteristics were determined. Extensive established populations of both plants were observed in SEA region and occasional occurrence of rare populations was also recorded in the Marmara region. The Canonical Correspondence Analysis indicated no relation between the distribution of plants and soil properties although large variation among soil properties within the surveyed sites was observed. The presence of plants was recorded in different habitats including roadsides, agriculture, abandoned lands and horticultural crops. Agricultural habitats were densely infested compared to other invaded habitats. Cotton, maize, pepper, eggplant, cucumber, tomato fields and olive orchards were the most infested agricultural crops. The infestation was greater in irrigated lands compared to that of natural habitats. The results revealed that both plants have sufficient potentials to expand their ranges in the Turkey. Therefore, a rapid response action needs to be taken against cut leaf ground cherry and Mexican ground cherry.

This study was funded by TUBITAK with grant number 113 O 790 as a part of Cost Action TD-1209.

Keywords: *Physalis angulata*, *Physalis philadelphica*, current distribution, survey, Turkey

P-124

Invasive Species Week - for the first time in the Netherlands

Wilfred Reinhold

platform Stop invasieve exoten, Amsterdam, Netherlands

In 2016, a National Invasive Species Awareness Week will take place in the Netherlands for the first time ever. Starting with a symposium on June 17th, the public can participate in several activities throughout the whole country, such as excursions, presentations and workshops until June 26th.

How to organise such an awareness week, with a small budget and a maximum effect?

Wilfred Reinhold, chairman of the Dutch platform "Stop invasive alien species" and initiator of this event, will tell about his experiences and the results, and will give many suggestions.

His advice: Please, do try this at home!

Keywords: alien, invasive, species, week, Netherlands, awareness, engage, public, communicate, organise

Contributions to the invasive species issues by the ESENIAS Tools Project

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The ESENIAS-TOOLS project “East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria” is an international research project for the ESENIAS Network (see <http://www.esenias.org/>) with particular focus on Bulgaria. The project is funded under the Financial Mechanism of the European Economic Area (2009-2014), Programme BG03 “Biodiversity and Ecosystem Services”. The aim of this project is to compile national and regional inventories of alien taxa, create awareness, conduct risk assessments and improve management strategies in the ESENIAS region. There are five working groups related to organisms, each focusing on one of the following topics: i) marine, ii) fresh water, iii) plants and fungi, iv) invertebrates and v) vertebrates. Database development, legislation, capacity building, awareness raising, and dissemination and networking are the other working groups. Some case studies will be investigated too: Estimating dispersal routes for IAS, Assessment of the impact of alien species on the biodiversity and endemism of ancient Balkan lakes (Lake Ohrid case study), Comparative study on the effect of hydrological regime on the distribution of the invasive diatom *Didymosphenia* germinate in extreme environments (Icelandic rivers and lakes, and Bulgarian high-mountain lakes), and Biological and ecological traits of invasive alien freshwater mussels in Bulgaria. One of the aims of the project is to make prioritisation of alien species at regional level, and to collect data and publish fact sheets for the priority species. The ESENIAS database has currently been developed, the website of the project updated and all information generated by the project will be uploaded. The final project book will include all main information generated during the project.

Keywords: plants, vertebrates, invertebrates, networking, capacity building, policy, awareness raising, marine, fresh water

Topic 11

Eradication, management & control of invasive species

P-126

A comparison of eradication techniques for invasive *Berberis aquifolium* in coastal dunes (Belgium)

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Non-native *Berberis aquifolium* is notoriously invasive in Belgian coastal dunes. With its strong clonal growth through suckers, this evergreen shrub outcompetes native species and affects dune succession. To prevent further secondary spread and mitigate its impact, there was an urgent need for knowledge on the effectiveness of control measures, both at the level of individual plants as on habitat level. Here, we report on two removal experiments. First, small *Berberis* clones were subjected to one of four treatments (manual uprooting, foliar herbicide application, stem cutting followed by herbicide or salt application), with regrowth being monitored up to one year after treatment. Plants proved most susceptible to foliar herbicide application (5% glyphosate solution), resulting in 77% of the clones apparently killed. Second, mechanical removal using a heavy excavator was applied in a highly infested area (350 m², with nearly 100% *Berberis* cover) and accompanied by manual removal of smaller rhizome/stolon fragments. The action was documented in detail and the outcome monitored in terms of regrowth from different depths. The rooting system appeared to be relatively shallow (30-40 cm). The limited regrowth from superficially buried rhizome fragments could easily be pulled out. We present some guidelines that may serve as a starting base for future control, and may become further refined as experience builds up.

Keywords: Invasive alien species, oregon grape, shrub, glyphosate, removal, ecological restoration, Mahonia

How many alien plants in the European terrestrial environments?

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In the framework of the European Alien Species Information Network (EASIN; <http://easin.jrc.ec.europa.eu>), an updated inventory of European terrestrial alien plants was created by critically reviewing and updating existing information in 26 global, European, regional and national databases and scientific literature (some species were added as EASIN-Literature from EPPO Bulletins and tickets opened via EASIN Editorial Board). In total, 7181 alien plants have been reported in the European terrestrial environments, including few cryptogenic and questionable species. A total of 391 species are tagged as "high impact alien species" according to existing species factsheets from CABI, DAISIE, GISD or NOBANIS. In addition, there are approximately 90 alien species to Europe which are not included in any of the larger databases (e.g. DAISIE, NOBANIS, CABI). For all species, information on countries where they might be native, taxonomy, synonyms, vernacular names, pathway of introduction and year of first observation is provided and it is accompanied by its source. Most of the reported species belong to Tracheophyta (99.1%). Magnoliopsida is the most numerous class (94.9%), followed by Liliopsida and Pinopsida. The species belong to a total of 262 families but Asteraceae (11%) and Poaceae (10%) are by far the most numerous ones. A total of 50 % of the low impact aliens and of 38 % of the high impact ones are partly native to Europe. It is expected that the EASIN database and tools will support the recent EU regulation on the prevention and management of the introduction and spread of invasive alien species in Europe.

Keywords: alien plants, terrestrial habitats, Europe, EASIN

Eradication and control of invasive species for the conservation of biodiversity in Mediterranean islands. The EU project LIFE PonDerat in the Pontine Archipelago, Italy

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Biological invasions have become one of the main drivers of habitat degradation and a leading cause of biodiversity loss in island ecosystems. The spread of invasive species is a major environmental threat in Mediterranean islands, hotspots of biodiversity that are rich in rare habitats and endemic species. Several projects have been launched in recent years in the many islands that lie off the Italian peninsula in an attempt to manage the invasions that are threatening the conservation of their native wildlife. Here, we present the EU LIFE project PonDerat (LIFE14 NAT/IT/544) which started in October 2015 in the Pontine Archipelago, a group of five volcanic islands located off the western coast of central Italy, that are important sites for the conservation of Mediterranean biodiversity.

This project, aimed at restoring the islands' natural ecosystems, focuses on the conservation of species and habitats that are protected by EU laws but are currently threatened by invasive plant and animal species. The main targets of these control and eradication measures are black rats (*Rattus rattus*), feral goats (*Capra hircus*), mouflons (*Ovis aries*) and invasive plants of the genus *Carpobrotus*.

Conservation measures focus on the seabirds *Puffinus yelkouan* and *Calonectris diomedea*, shearwaters of the family Procellariidae, which are endemic to the Mediterranean and are listed in Annex I of the European Bird Directive. These birds nest in colonies on the rocky coasts of the islands and are severely threatened by rats, which prey on the birds' eggs and nestlings. Conservation measures also focus on several island habitats of great biogeographical value, which are listed in Annex I of the European Habitats Directive (code 1240, 3170*, 5320, 5330, 6220* and 9340) and are seriously threatened by introduced herbivores and by the spread of invasive plants.

In addition to measures aimed at the eradication and control of invasive species and to related biosecurity actions, the project includes a communication plan designed to raise awareness in the local population on the risks due to the spread of alien species. The main outcome expected from this project is that the restoration of ecosystem functions will enhance the breeding success and population size of shearwaters and lead to the recovery of target habitats. The improved natural conditions of the islands are also expected to favour other species of high conservation value, particularly bird species nesting on the ground or close to it, and migratory bird species that use the archipelago as a major stop-over site.

Keywords: Biodiversity hotspots, *Carpobrotus* sp.pl., endemic birds, *Rattus rattus*, small islands

EDDMapS Framework for Education, Management, Aggregation and Visualization of Invasive Species Occurrences across North America

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EDDMapS' primary goal is to discover the existing range and leading edge of invasive species while documenting vital information about the species and habitat using standardized data collection protocols. EDDMapS (www.eddmaps.org) allows for data from many organizations and groups to be combined into one database to show a better map of the range of an invasive species. Goals of the current project include: integration of existing regional datasets, increase search options on EDDMapS website, update NAISMA (North American Invasive Species Management Association) Invasive Plant Mapping Standards, coordinate with local, state and regional organizations to develop early detection networks, and to better integrate and utilize the capabilities of smartphones into the operational programs. After eleven years of development of EDDMapS, it has become clear that these local organizations are key to developing a successful early detection and rapid response network.

The University of Georgia Center for Invasive Species and Ecosystem Health has developed 20 location or project-based portals to support data entry into EDDMapS. EDDMapS has been implemented in 45 U.S. states and 4 Canadian provinces. This presentation will feature case studies of how the EDDMapS framework has been used for education, management, aggregation and visualization of invasive species occurrences.

Keywords: Invasive Species, education, management, data aggregation, data visualization

The impact of short term exposure to freshwater on marine fouling non-native species in three Scottish marinas

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Artificial structures in marinas are especially favourable habitats for many marine invasive non-native species (NNS). Reducing establishment of non-native species in marinas may reduce spread by recreational vessels. Marinas with a nearby freshwater source have fewer NNS, suggesting freshwater may be a possible tool for controlling NNS spread. This study was conducted to see if freshwater could be used as an effective treatment to reduce colonisation of marine fouling non-native species on artificial structures in marinas. The effects of 1-hour freshwater immersion were tested on experimental biofouling communities in three Scottish marinas with differing salinity regimes. 8 week old communities developed on settlement panels suspended from floating pontoons from July – August 2016 were immersed in either freshwater or ambient seawater, before being returned to their initial position on pontoons. Recovery of biofouling communities was monitored over an 8-week period post-treatment. Salinity varied over the growth and recovery phase to differing extents in each marina, with freshwater input affecting salinity variability. Fouling communities from the marina with the most stable high salinity conditions displayed the largest change to freshwater immersion. Comparing response to treatment between native and non-native species allows us to see if freshwater immersion may be an appropriate biosecurity tool for use in marinas.

Keywords: marinas, freshwater, marine biofouling, biosecurity

The Japanese Knotweed Project 2008-2016: Long-term management of *Reynoutria japonica* and *R. sachalinensis* in Switzerland

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The goal of the project is to evaluate different variations of chemical and mechanical treatments of Japanese Knotweed within a timeframe of 8 years regarding effectiveness, costs and side effects on non-target organisms but also to optimise management methods.

About 90 Knotweed sites are distributed over six cantons, situated in public places and mostly in the responsibility of public authorities. The selection criteria included previous treatment, legality (there are legal restrictions on the application of herbicides, e.g. along watercourses) and accessibility. Their state (population size, number of stems, condition of stems, etc.) is recorded annually.

Several control sites with no interventions have been observed. During the first three years the mechanical treatment (cutting) was executed six and in the following years three times per year. In 2008 the chemical treatment comprised 15 different methods using glyphosate. In 2014 they were reduced to three variations. In order to find and treat the residual Knotweed plants between the rapidly growing secondary vegetation an efficient and pertinent maintenance became even more important after only three years of chemical treatment. Therefore, it wasn't only the treatment method alone but the whole approach throughout the year that became part of the experiment. Because the experimental design involved employment of public maintenance staff the challenge also lay in their instruction, guidance and coordination. At the same time these experiences gave valuable insights for future "Best Practice" guidelines.

The findings from phase I (2008-2012) are already presented in an extensive final report. Although not all of the phase II (2013-2016) data could be analysed to their full potential yet there are already a lot of findings to be presented. Thanks to the long-term monitoring it could be shown that supposedly eliminated populations can re-grow after years with no aboveground Knotweed biomass. It could also be worked out how the maintenance service can optimise their interventions on Knotweed sites and which results can be expected under the given legal conditions.

The European Knotweed Control Network was founded 2014 during a Knotweed workshop in Zürich. It consists of Knotweed experts from all over Europe and has the stated goal to enable an intensive exchange of knowledge and experience on methods and practices to control alien Knotweed. The coordination of activities against Knotweed ensures that resources are used efficiently by reducing duplication of work and by catalysing innovation.

Keywords: Japanese Knotweed, Switzerland, Management Methods, Glyphosate, www.europeanknotweedcontrolnetwork.eu, www.biosicherheit.zh.ch

P-133

Monitoring and control activities of the invasive North American crayfish *Procambarus clarkii* in wetland areas of northern Tuscany, Italy

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The project LIFE11NAT/IT/094 SOS Tuscan Wetlands (2012-2017) aims to reverse the current tendency of radical biodiversity loss and population decline of several species of conservation concern, in the wetlands of Northern Tuscany. This will be achieved through habitat restoration and control of the alien invasive species established in the area that are causing severe impacts on native species and ecosystems. Among them, the red swamp crayfish *Procambarus clarkii* is one of the most highly invasive species in the area exerting a strong pressure on species and habitats.

Here, we report the results of the monitoring and control activities conducted on red swamp crayfish since May 2014. The activities are carried out in two areas, Sibolla lake and Ramone marsh (both included in Sites of Community Importance), for 10 consecutive days per month, from May to August, per year using baited traps. C.P.U.E. index (Catch per Unit Effort) is used to evaluate population abundance.

The control activities have led to a significant decrease of C.P.U.E. index values through time in both areas, showing the efficacy of intensive trapping that however should be coupled to other control techniques (e.g. male sterilization) to increase its effectiveness.

Keywords: control, alien species, *Procambarus clarkii*

What is the most efficient efficacy measure of non-chemical control of common ragweed?

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The North American *Ambrosia artemisiifolia* L. is one of the worst IAS to Europe. Agricultural yield losses, costs for control as well as health costs exceed financial losses caused by other vascular plant pests. In many situations, herbicides cannot be applied, thus non-chemical control measures have to be established. Cutting and outcompeting ragweed are favored tools in sensible environments. I.e. on roadsides, ragweed was favored to spread due to inappropriate cutting regimes and prevention of competitive exclusion by native plants.

As series of experiments were set up to find optimal cutting regimes and optimal competitive seed mixtures in infested habitat types that are under non-chemical management. Cutting experiments under controlled conditions indicated the high regenerative power after cut – measured as number of regrown shoots/biomass or inflorescences (Bohren et al. 2004, Milakovic et al. 2014a). Long-term field experiments testing various cutting regimes made evident that ragweed is able to regrow from lower buds and produces seeds after cut (Karrer 2014). Milakovic et al. (2014b) found that the number of produced seeds could be minimized by adequate mowing regimes. The authors also could show that the number of cuts must not be higher than regular but they have to be set more sophisticated at dates that consider the phenological development of ragweed and its regrowth potential. In all this cutting experiments the efficacy was measured by reproductive trait like number of male inflorescences or number of female flowers/fruits.

The success of control measures against annual weeds like common ragweed depends very much on the number of seeds produced. Seed survival and seed longevity in the soil is crucial for long-term efficacy of control. Milakovic & Karrer (2016) showed that the above mentioned optimized cutting regime also was very efficient in reducing the resulting soil seed bank with respect to both absolute number and viability of ragweed seeds.

The competitive effect of different added seed mixtures to ragweed-infested soil was evaluated also by counting the number and viability of ragweed seeds under different cutting regimes – in greenhouse experiments and under field conditions. Final soil seed bank analysis after a long-term field experiment indicated that applying the fitted mowing regime is more efficient than the competitive performance of the tested seed mixtures.

In ecological terms, soil seed bank is the most relevant efficacy measure of control activities against annual plants like common ragweed.

Keywords: Mowing regime, competitive seed mixture, soil seed bank, seed viability

Biological control of silverleaf nightshade (*Solanum elaeagnifolium*), an effort to protect Mediterranean agriculture and sensitive ecosystem

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Solanum elaeagnifolium (silverleaf nightshade) is one of the most prominent alien, invasive weeds of the Mediterranean Basin. Endemic to southwestern US and northern Mexico, it reproduces mainly vegetatively but also sexually to invade new, distant areas. It is toxic to some livestock and by producing toxins, prevents native plants from competing with it. It occupies arable, pastoral, urban and sub-urban areas. The extensive and deep perennial root system allows the weed to out-compete many crop plants for moisture and nutrients: further, it is resistant to drought and tolerates saline conditions. It thus represents a serious threat to lands suitable for agriculture in Mediterranean areas and jeopardizes the food security of the area. Climate change and the increase of global temperature combined with increase in international trade could help the weed to establish in central and northern Europe with great damage to its agriculture and ecosystem.

In the long term, biological control is the most effective tool to control *S. elaeagnifolium* since other methods such as chemical and mechanical have been proved to be costly and have undesirable side effects for ecosystems and biodiversity in protected areas. Research in the native range of *S. elaeagnifolium* has shown that there are many potentially host-specific natural enemies of the weed which could be tested and used to reduce the weed's populations and its invasion into new areas. Some of these, such as *Frumenta nephelomicta*, and *Frumenta* sp., (Gelechiidae) were released in South Africa nearly 45 years ago, without success, but the leaf-feeding beetles *Leptinotarsa defecta* and *L. texana* (Chrysomelidae), released in 1992, inflict moderate and extensive damage, respectively, on their host plant: *L. texana* has proved to be highly effective in suppressing *S. elaeagnifolium* and combating the weed's expansion in that country.

Keywords: Biological control, agriculture, ecosystems, biodiversity, food safety

Factors affecting the recruitment of alien woody plants by native herbivorous insects

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Many factors can influence the degree of adoption of exotic plants by indigenous herbivores in the region of introduction. We used field observations on phyllophagy by leaf chewers and leaf miners on native and alien woody plants to define the factors affecting colonization of alien plants by indigenous phyllophagous insects. The study was performed on 150 woody plant species (trees and shrubs) from 21 families and 43 genera growing in the biggest botanical garden of Siberia. We tested the effect of woody plant origin (alien vs. native plants), taxonomic relationship of the alien host plants with the native flora, the date of introduction of the alien plants and their abundance in the region on abundance and richness of phyllophagous insects.

The alien woody plants were, on average, much less attacked by leaf miners and leaf chewers than native plants, which was in agreement of the enemy release hypothesis. Taxonomically isolated alien plants (i.e. without congeners in Siberia) were significantly less attacked by the two insect guilds and carried fewer leaf miner species than alien plants having congeners in the studied region. Leaf miners' abundance and species richness increased with the years of presence of the plant in the botanical garden. Damage by chewers significantly increased with the frequency of planting of the alien woody host plants outside the botanical garden. No significant difference was detected in the level of insect damage, abundance and richness between exotic plants from different continents.

Besides the ecological implications of the results, this study also underlines the importance of the use of botanical garden collections for investigations on invasion ecology, especially in regions where field work is logistically difficult.

The study was supported by LE STUDIUM®, Institute for advanced studies - Loire Valley, France (grant No INRA-URZF-007), the Russian Foundation for Basic Research (grant No 15-29-02645) and COST Action FP1401 – A global network of nurseries as early warning system against alien tree pests (Global Warning).

Keywords: phyllophagy, invasive alien plants, botanic gardens

P-137

Management of *Heracleum mantegazzianum* Somm. et Lev. (Apiaceae, Spermatophyta) in the Upper-Sûre region in Luxembourg

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There are different neophytes occurring in the Upper-Sûre region in the north-west of Luxembourg (Ardennes). The Giant Hogweed (*Heracleum mantegazzianum* Somm. et Lev.) is by far the most precarious, but also quite easy to eradicate.

The Giant Hogweed was probably introduced in Luxembourg in the 1930ies and began its invasion, after a certain period of latency, in the last two decades – mainly on riverside banks. Since 2009 the Nature Park Upper-Sûre (Naturpark Öewersauer), together with the River-Contract, is persistently implementing the action plan “*Heracleum mantegazzianum*” in the entire Upper-Sûre catchment, where *H. mantegazzianum* plants are growing predominantly on riversides and in alluvial meadows.

The Giant Hogweed is controlled by root cutting and, in case of flowering, by umbel removal. The results of the campaign and of the consequent monitoring are presented. They point out that these simple mechanical methods show excellent results when monitoring and management is recurrently continued until the soil seed bank is depleted and when new infestations by human means, specifically by apiarists, are counteracted.

Keywords: Giant Hogweed, distribution, invasion, eradication, Upper-Sûre, Ardennes, Luxembourg

Evaluating an effective treatment to control/eradicate the invasive weed *Oxalis pes-caprae*: indications from a field experiment in a Mediterranean island.

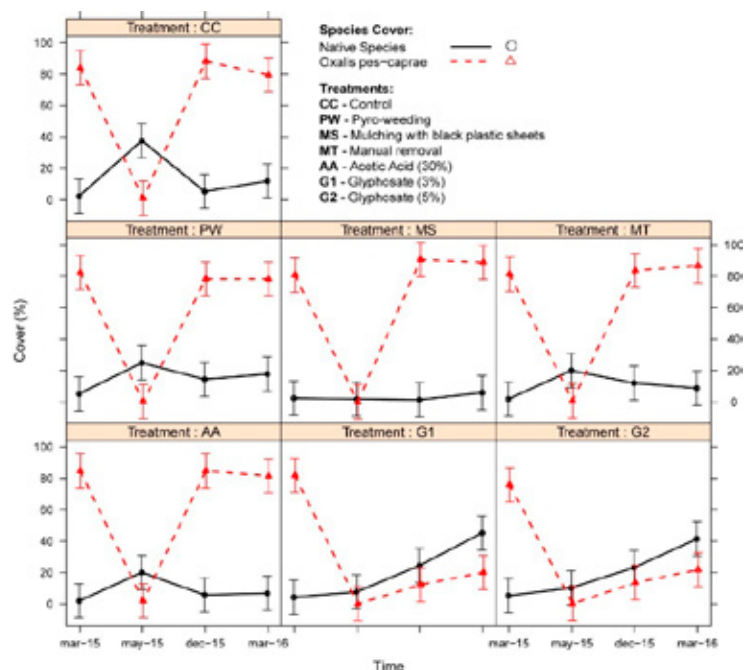
Lorenzo Lazzaro, Giulio Ferretti, Bruno Foggi, Elisabetta Bianchi, Renato Benesperi

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Oxalis pes-caprae is a widespread invader native from South Africa, which has spread widely across southern Europe, North Africa and Southwest Asia and is particularly aggressive in the Mediterranean region. This species is a common weed particularly in anthropized, arable and disturbed habitats. Its main ecological impacts are related to the possible suppression of other ruderal weedy species, leading to serious problem where the arable flora is of conservation value, as over much of the Mediterranean old fields. Furthermore, this species has mainly socio-economic impacts related to livestock and field losses linked to its weedy behaviour. The treatment option for this species has been poorly investigated, and most of the main chemical and biological control methods are usually considered inadequate or barely effective in the control of this species. Toward the aim to test a wide set of treatment option on the field, we set an experiment in the island of Montecristo (Central Mediterranean). In the experiment, we tested the effect of six different treatments on *Oxalis pes-caprae* and on the native flora. Treatment went from biological to chemicals, including manual control and removal, covering with a mulching sheet, pyro-control with a flamethrower, aspersion with acetic acid (30% solution) and with two different concentration of glyphosate (3% and 5% solutions respectively). The total cover of *Oxalis pes-caprae* and of the other native plant was sampled before the treatment and several times in a year after the treatments. Our results show that the only effective treatment was the use of glyphosate. Particularly one year after the treatments *O. pes-caprae* cover decreased greatly in the plots treated with glyphosate, while non-significant decrease was recorded in the plots subjected to other treatments. No significant differences were detected also among these treatments and the control plots, indicating a total inefficiency of these treatments in the control of the weed. Furthermore, we recorded an increase in the cover of native species in the plots treated with herbicide, while with all the other treatments native species continued to be scarce or absent being strongly outcompeted by the weed. Our results demonstrate the efficiency of chemical treatments in the control of the weedy alien species *O. pes-caprae*, also demonstrating the benefices that native species may rapidly show even adopting a such impacting control measure.

Figure caption. Variation of *Oxalis pes-caprae* and other native species cover in the time according to the treatment.

Keywords: herbicide, alien, glyphosate, manual control



Evaluating an effective treatment to control/eradicate the invasive weed *Oxalis pes-caprae*: indications from a field experiment in a Mediterranean island.

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Figure caption. Variation of *Oxalis pes-caprae* and other native species cover in the time according to the treatment.

Keywords: herbicide, alien, glyphosate, manual control

The results of long-term eradication efforts of alien hogweeds in Estonia, Europe

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Giant hogweed (*Heracleum mantegazzianum*) and Sosnowsky's hogweed (*Heracleum sosnowskyi*) are listed as invasive species likely to disrupt natural balance according to the regulation of the Minister of the Environment of Estonia. Sosnowsky's hogweed is also listed as the species of European Union concern in the annex of EU Regulation 1143/2014 on Invasive Alien Species. A noteworthy increase of range invaded by these phototoxic and noxious alien hogweeds started in the mid of the 20th century in Estonia. Since 2005, over 99% of the mapped area occupied by alien hogweed colonies (approximately 2300 hectares in 2016) has been under state-controlled eradication effort each year. Due to the enduring seed bank of hogweeds, solid eradication works must be conducted at many (at least 4–5) successive years to start the significant decrease in the density of hogweed stands. As a result of long-term eradication efforts, the further widespread dispersal of hogweeds colonies has stopped in Estonia.

Keywords: alien hogweeds, giant hogweed, Sosnowsky's hogweed, effectiveness of eradication effort

How to control an invasive forest pest? Biological control of invasive *Dryocosmus kuriphilus* with introduced parasitoid *Torymus sinensis* in Croatia, Slovenia and Hungary

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Dryocosmus kuriphilus is considered as one of the major pests of sweet chestnut (*Castanea*) and the effective method of controlling its populations and damage is classical biological control with its introduced parasitoid *Torymus sinensis*. *T. sinensis* is a univoltine, host specific parasitoid, phenologically synchronized and morphologically adapted to *D. kuriphilus*, it has good dispersal ability, builds up populations quickly and effectively controls the pest already few years after release. We describe the first results of introduction and release of *T. sinensis* for controlling the populations of invasive *D. kuriphilus* in sweet chestnut forests and orchards in Croatia, Hungary and Slovenia. Withered *D. kuriphilus* galls with *T. sinensis* larvae were collected in Torino vicinities, Italy in March 2014 and 2015. After emergence, males and females were put together, kept at 14°C and fed with liquid honey until release. To confirm the establishment of population of *T. sinensis* on release sites in Croatia, Slovenia and Hungary morphological and DNA identification were used. In total 10,590 females and 5,295 males of *T. sinensis* were released in sweet chestnut forests across in Croatia, Hungary and Slovenia in 2014 and 2015. Minimum release number of *T. sinensis* was 100 females/50 males and maximum 1,200 females per site. Subsequent releases with larger number of females (1,200 and 800 in two years) resulted in rapid establishment of population of *T. sinensis* and parasitism rates of 76 % only one year after the first release was achieved. Establishment of population of *T. sinensis* was confirmed with molecular analyses and morphological identification. High levels of genetic diversity indices showed that populations of *T. sinensis* did not suffer from bottleneck-induced founder effect phenomenon. Prior to release of *T. sinensis* all advantages and disadvantages of introduction of this alien biocontrol species into natural stands in Croatia, Hungary and Slovenia have been considered.

Keywords: *Torymus sinensis*, classical biological control, parasitism rates, rearing and release, parasitoid, sweet chestnut gall wasp,

Advanced biotechnology for invasive species management

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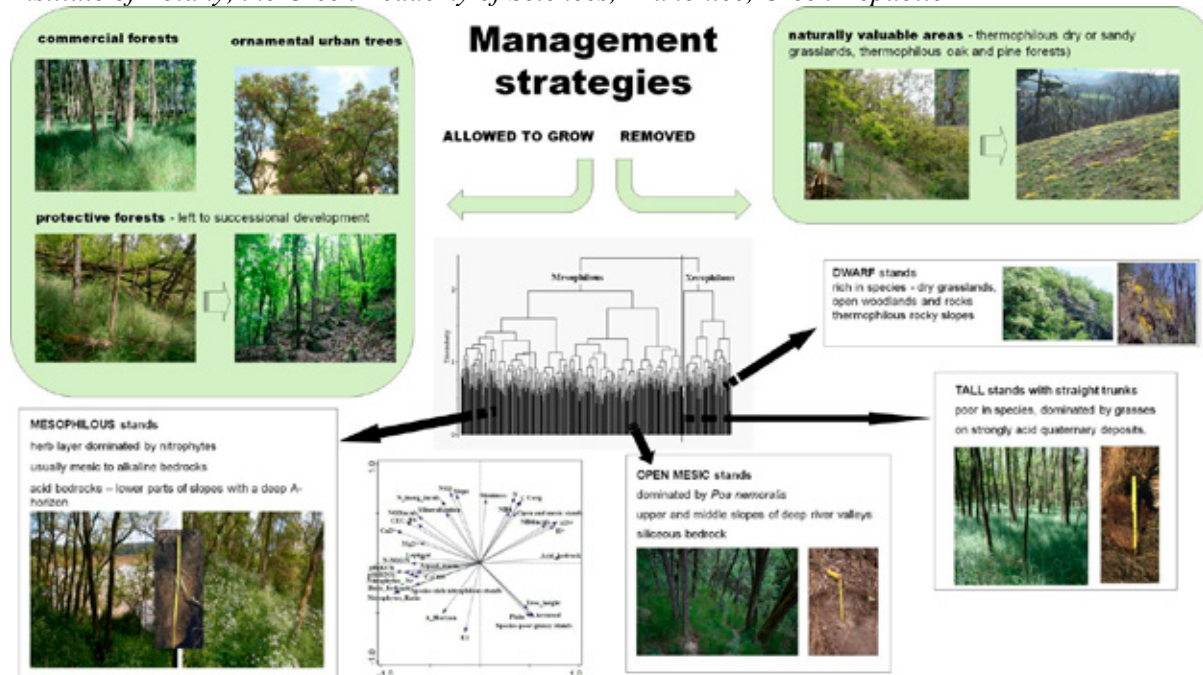
Increasingly, genetic tools are being used to detect and solve pressing environmental, social, and health-related challenges. For example, environmental DNA (eDNA) is being employed to detect and monitor the presence of potentially invasive species in water bodies or other moist environments. Advances in biotechnology such as gene editing, RNAi, and gene drives are currently being explored as a means to eradicate and control invasive species such as mosquitoes that carry disease. By altering the genomes of entire populations of wild organisms, genetic editing may improve capacities to prevent, eradicate and/or control populations of invasive species or their vectors currently thought to be unmanageable. However, there is a need to carefully explore the potential ecological, socio-cultural, and political ramifications of using advanced biotechnology to address invasive species, including the possibility that gene-edited organisms may spread across ecological and jurisdictional borders. This presentation is meant to open a productive discussion amongst invasion researchers to identify the pros and cons of using this technology to manage invasive species and to create a pathway to assess these products in a rational manner in this rapidly developing dynamic field.

Keywords: DNA barcoding, gene editing, gene drives, RNAi

Success of black locust (*Robinia pseudoacacia*) - the true story

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Black locust (*Robinia pseudoacacia*) belongs to the most invasive woody species in the world. Imported from North America to Europe for ornamental purposes as early as the beginning of 17th century, it has become widely naturalized in temperate and subtropical regions over the world. It soon became a popular forest tree for high quality timber, honey making, erosion control, amelioration and reclamation of disturbed sites, especially along railways and on steep eroded hillsides along rivers. It is a pioneer species known for its rapid growth, sprouting ability and nitrogen fixation. It is able to tolerate extremely diverse physical-chemical soil conditions, from extremely acid to strongly alkaline, and from medium to highly base saturated soils with a gradient of different subsurface stoniness, with high tolerance to air pollution and salinity. Once introduced, it soon becomes a dominating species. Due to its rapid growth and ability to fixate atmospheric nitrogen it behaves as an ecosystem engineer, not only changing the biogeochemical cycles but also creating specific plant assemblages, often highly different from natural ones. In Europe, it invades (i) natural habitats, such as thermophilous grasslands, sandy soils, shrubbery and open azonal forests, and (ii) man-made habitats, such as urban-industrial wastelands, fallow lands, disturbed traffic corridors and burnt sites. In Central Europe, there are four types of stands differing in soil conditions: (1) species-rich nitrophilous stands on alkaline to acid bedrocks; (2) tall, species-poor grassy stands on strongly acid quaternary deposits; (3) open, mesic stands dominated by *Poa nemoralis* on upper slopes of deep river valleys on siliceous bedrock; and (4) dwarf, shrubby stands on thermophilous rocky slopes. Despite of economic benefits, it poses serious threat for biodiversity. Conservation measures are difficult due to vigour sprouting and growth. Even if the removal is successful, nitrogen enriched soils make the restoration difficult. There is also socio-economical point of view, as the species is widely used in the forestry and popular among public. Attempts for complete eradication would therefore be neither possible nor wise, and site-specific strategies must be applied for invasion management, ranging from complete eradication at sites with high natural value to coexistence at urban and intensive agriculture landscapes. Remote sensing can help for both monitoring and selecting the best management strategy.

Keywords: ecosystem engineer, forestry, invaded habitats, monitoring, physical-chemical soil conditions, remote sensing, site-specific management strategy

P-143

Population control of non-native round gobies – modelling different removal strategies

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An optimal population control strategy of invasive species needs to be effective, efficient and supported by relevant decision makers. Usually, research on population control methods addresses only one or two of these criteria. In this talk, we present a strategy to manage round goby *Neogobius melanostomus* that includes all three dimensions: effectiveness, efficiency and feedback to decision makers.

Round goby is a non-native invasive fish species spreading in Europe and North America. It was first detected in the High Rhine in Switzerland 2012, where it has established an increasing population and potentially threatens native biodiversity. We follow a matrix-based population modelling approach to analyse two different round goby control options: removing adults and removing eggs. The two options are analysed regarding different scenarios, e.g. controlling a newly colonized area vs. controlling a population reaching the carrying capacity of the ecosystem. Furthermore, we evaluate how much effort needs to be invested to successfully carry out the population control strategy. Communication, priority setting and feedback sessions with decision makers responsible for the implementation of population control strategies are crucial during all steps of such a project.

Keywords: population control, matrix model, round goby, neogobius melanostomus

P-144

Optimal planning for eradicating multiple invasives from an oceanic island.

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Many islands are invaded by multiple invasive species. Due to their size, islands are often promising locations for eradicating invaders. Multi-species eradications are essential for conserving the biodiversity of these islands, but experience has shown that eradicating species in the wrong order can be disastrous for endemic species. Managers not only have to decide on how to eradicate each invasive species, they also need to determine when to target each species and commonly these decisions are made under a limited budget. We use dynamic control theory to show that invasive species should be eradicated in a particular order when resources are limited. We focus on a frequently occurring system of multiple invasive species, where one invasive predator consumes two prey species (of which one is endemic, one is invasive). We find that for this common system it is always best to target the predator first, and thereafter gradually shift efforts towards the invasive prey. Targeting both species simultaneously is substantially suboptimal. As our approach and findings apply to all systems of this common ecosystem and they could therefore aid decisions for many data-poor eradication projects.

Keywords: invasion ecology, dynamic control, Channel Islands, optimal eradication,

P-145

Management of invasive exotic mosquitoes in the Netherlands

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Since 2005, several species of alien invasive mosquitoes are found in the Netherlands. Some species, such as the Asian tiger mosquito (*Aedes albopictus*) can infect people with viruses such as dengue, Chikungunya and Zika, they are being introduced with the import of used tires and Lucky bamboo. From one species, the Asian bush mosquito (*Aedes japonicus*), there already is an established population in the city of Lelystad.

What does the Dutch government do to manage the introduction and spread of these risky mosquito species, and what are the options?

Keywords: invasive, alien, species, management, mosquitoes, Netherlands, health

P-146

Just invasive? Not established? A muskrat (*Ondatra zibethicus*) population in a submontaneous river system

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Nationaal Museum of Natural History, Luxemburg, Luxembourg

After its first introduction into the wild in Bohemia and, later, its escape from fur farms in France, the semi aquatic muskrat (*Ondatra zibethicus*) reached Luxembourg in 1956. A trapping management was introduced in Luxembourg in 2008 because of severe damages to freshwater mussel communities. This investigation gained scientific support in 2009. The research objectives were, firstly, the investigation of the muskrats' spatiotemporal patterns and, secondly, observing the re-colonisation of the managed habitats after the removal of animals. In addition, the influence of muskrats on freshwater mussel communities should be evaluated. Marking with subcutaneous transponders and radio-tracking with implant tags were used. During the first 15 months a suspiciously low population density with temporary absences was observed and the muskrat's typical high reproduction rate could not be detected. Therefore, the hypothesis was formulated, that there is no constant population of muskrats, rather a yearly immigration into the research area.

Keywords: muskrat, radio-tracking, implant tags, Capture-mark- recapture, spatio-temporal patterns, re-colonisation of managed habitats, jaw-trapping

Climatic suitability ranking of biological control candidates: a biogeographic approach for ragweed management in Europe

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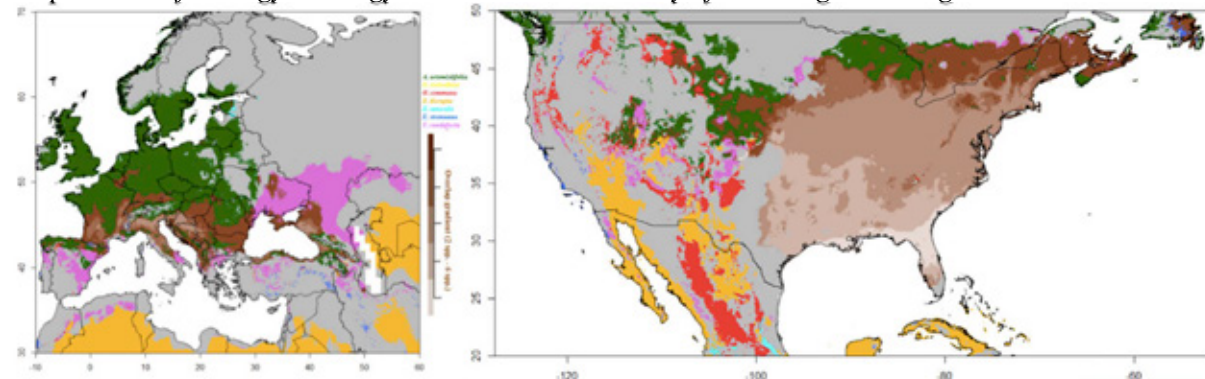
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Biocontrol using natural antagonists from the invaders' native range has been a successful management tool against invasive alien plants. Selection of candidate agents remains a critical step in a biocontrol program before more time-consuming tests are conducted. Here for the first time, we simultaneously modelled the distributions of a plant invader and of its potential biocontrol agents in view of selecting candidates that potentially cover a large range of the target invader. We studied *Ambrosia artemisiifolia* (common ragweed), native to North America (NA) and invasive worldwide, and six NA biocontrol insects as candidates for the introduced European (EU) range of ragweed. More specifically, we ask: 1) what percentage of the suitable ragweed range is also suitable for the six candidates, both under current and future bioclimatic scenarios; 2) does this relative overlap in NA correlate with their projected overlap in EU; and, 3) which part of the suitable ragweed range in EU is likely to remain uncovered by these candidates? We thus constructed species distribution models based on worldwide occurrences and important bioclimatic variables for each species. Ordination techniques were used to explore climatic constraints of each species and to perform niche overlap and similarity tests with ragweed. Our results show a large overlap in climatic space between the insects and ragweed, but a considerable discrepancy in the geographic range overlap between EU (31.4%) and NA (83.3%). This might be due to niche unfilling and expansion of ragweed in EU and the fact that habitats with high ragweed occurrences in EU are rare in NA and predicted to be unsuitable for the candidate agents. Total geographic range of all insects combined is expected to decrease under climate change in both ranges, but the six insects will respond differently. Importantly, the relative geographical coverage of a plant invader by biocontrol candidates in the native range is largely transferable to the introduced range, even when the invader shifts its niche. Our analyses also provide a guide for which abiotic conditions to select for in developing climatically adapted strains for particular regions in Europe where ragweed is currently unlikely to be controlled.

Keywords: *Ambrosia artemisiifolia*, biological control, biological invasions, climate change, niche overlap, species distribution model

Tackling aquatic invasions in Europe: the Aquainvad-ED project

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Aquatic Invasive Species (AIS) are increasing due to the synergistic effects of climate change and habitat destruction. AIS heavily affect biodiversity and human health, and cause loss of ecosystem services; therefore, their control and management have now become a priority, particularly in the light of the new EU regulation 1143/2014 on invasive species. Successful management of AIS requires several steps: early detection, identification of routes of introduction and pathways of dispersal, and development of efficient control measures. Public awareness and stakeholder involvement are also critical for preventing new introductions and for mitigating the impact of existing ones. The main research goal of the project Marie Curie 2014 ITN H2020 Aquainvad-ED (AQUAtic INVaders: Early Detection, Control and Management; 2015-2019; <http://www.aquainvad-ed.com/>) is to exploit novel tools combined with the power of crowd data sourcing (citizen science) to develop innovative methods for early detection, control and management of AIS. Eight PhD fellows are involved in Aquainvad-ED and are dedicated to four projects: (1) development and application of novel methods for early detection AIS; (2) identification of vectors of introduction and pathways of dispersal; (3) impacts of freshwater and marine invaders; and (4) risk assessment and control of AIS. In order to develop multidisciplinary approaches to address these issues, the fellows are working in an international consortium (UK, Spain, Italy) composed by scientists and professionals from three universities (Swansea University, Universidad de Oviedo, Università degli Studi di Firenze), one technological institute (AZTI), two governmental agencies (Natural Resources Wales and Cardiff Harbour Authority), one NGO (Wye & Usk Foundation) and five SMEs working in fundamental and applied aspects of AIS (Neoalgae, Natural Applications, NEMO, Ecohydros and Itinera).

Keywords: aquatic species, invasive, early detection, control, pathway

P-149

How do non-governmental organizations help to minimize the negative impact of invasive alien species?

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Pro Natura, Basel, Switzerland

Pro Natura, an NGO founded in 1909, is the largest organization for nature conservation in Switzerland. Since the end of the last century Pro Natura has been involved in the battle against invasive alien species. This is done by raising public awareness, strengthening political relationships, targeting environmental education and specific eradication measures in its nature reserves.

Therefore, Pro Natura felt that it was important to develop our own position paper outlining our future plans: this indicates how to reduce the negative impact, mainly on biodiversity, of invasive alien species. So far, few NGOs have developed position papers dealing with invasive alien species.

During this talk I will present the position paper and outline the work done by Pro Natura to minimize the negative impact of invasive alien species.

Keywords: NGO, Position paper

Topic 12

Biosecurity and risk assessment, including early detection and rapid response

P-150

The use of online sources to assess spatial distribution of the non-native European catfish *Silurus glanis*

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The management of invasive fishes depends on updated data about its distribution and dispersal rates. We obtained online and published data about European catfish, *Silurus glanis* presence, a recent invader in the Tagus basin (Iberian Peninsula). Eighty records were collected mainly from anglers' fora and blogs but also from Youtube. Since 1998, the European catfish expanded its range over 700 km of the river network, mainly occurring in reservoirs and in high order sections. Dispersal was human mediated and natural, with the former being prevalent during the first years of invasion, among locations farther than 50 km away from previously known distribution areas. The predominant dispersal direction was downstream. The analysis of online data from anglers provided very valuable information about the distribution and dispersal patterns of this non-native fish. We recommend the use of this methodology as preliminary and exploratory evaluation for future studies.

Keywords: *Silurus glanis*, European Catfish, dispersal, youtube, fora, expansion, distribution

P-151

Developing the official Invasive Alien Species List for Mexico

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In April 2010 an important step was undertaken to protect Mexican biodiversity from invasive species. The National Law for Environmental Protection and the General Law of Wildlife were modified to include the term “invasive alien species” for the first time and to establish the measures to attend the issue. One of the main statements requires the Mexican government to develop official lists to identify the alien species that will be subject to regulations, including species that might carry IAS into the country. A thorough revision of literature on existing risk assessment protocols and prescreening schemes, which vary in scope and completeness from Australia, the approach from the United States Canada and Mexico and several European countries, made evident that none of these could be directly applicable to Mexico. The National Commission for the Knowledge and Use of Biodiversity (CONABIO), an inter-ministerial commission and the lead organization regarding invasive species, coordinated a group of experts from other governmental institutions, Civil Society Organizations and Academia, to develop a generic prescreening tool, applicable to all taxonomic groups, which allows to the identification of potentially high risk candidates to include in the official lists. We have currently evaluated over 450 species and a first draft of the list has been submitted to the Ministry of Environment for its approval.

Keywords: prescreening tool, rapid risk evaluation

Recent Plant Invasions in Canada

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The vascular flora of Canada consists of approximately 5,087 species, of which 3,858 are native and 1,229 have been introduced. Of the introduced species, 40% are considered weedy or invasive. Canada's recorded history of plant introductions dates back about 400 years, beginning with the settlement of Samuel de Champlain in 1605. During this period, the number of new invasive species grew slowly from 1600-1800, then increased rapidly from 1800-1900, followed by a slower, linear period of accumulation which continues to the present day. It is estimated that about 3.0 new species were added per year over this entire period, of which 1.2 per year have become invasive. During the slower linear phase of the 20th century, the rate of establishment of invasive plant species has been estimated at 0.58 species per year.

New invasive alien plants continue to establish in Canada in the 21st century. However, this period marks the beginning of a new era with significant phytosanitary oversight and a focus on prevention. The Canadian Food Inspection Agency (CFIA), Canada's National Plant Protection Organization, began conducting pest risk analyses on new plants to Canada in the year 2000. These analyses are conducted in accordance with international guidelines for pest risk analysis established by the International Plant Protection Convention. In the CFIA, a pest risk analysis begins with a categorization to determine if a species qualifies as a potential quarantine pest. For species that qualify, the process continues with a full weed risk assessment to evaluate the probability of entry, establishment, and spread in Canada, and the potential economic and environmental consequences. Subsequently, risk management documents provide an evaluation of options to reduce the risk of introduction and spread of a pest, and may also be used for risk communication and public consultation.

Since the year 2000, the CFIA has categorized over 360 plant species, largely as a result of requests for import, weed interceptions in imported commodities, and new detections in the Canadian environment. Focusing on the last category, this poster highlights a number of the most significant new plant species that have been detected and become invasive in Canada in recent years. For each species, the date and location of initial discovery, most likely pathway of entry, and status of the pest risk analysis process is provided.

References

Canadian Food Inspection Agency. 2008. *Invasive Alien Plants in Canada*. CFIA. Ottawa, ON. 72 pp.

Keywords: invasive alien plant, pest risk analysis, pathway, weed

Species distribution modelling and risk maps for priority invasive alien plants in the EU

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Species distribution models are commonly used to map regions at risk of invasive alien species (IAS) establishment. These characterise relationships between known species occurrences and environmental gradients such as climate and land use, in order to predict the suitability for occurrence of a species in any location. For IAS, this can mean identifying suitable regions that a species has not yet dispersed to and invaded. As such, species distribution models increasingly play a role within IAS risk assessments. In a new project that supports the recent EU law on IAS (Regulation (EU) no. 1143/2014) we are developing a standardised, open-source workflow for IAS distribution models. The modelling workflow is being applied for the risk assessment of 16 of the highest priority invasive alien plants. These are currently absent or rarely recorded in Europe but may have high potential for invasive spread and impact if barriers to introduction or dispersal are overcome. As such there is still capacity to reduce or mitigate their risk by trade restrictions and timely management, motivating high quality risk assessment to justify and prioritise such action.

Here, we present the methodology and preliminary results from the species distribution modelling. The models were developed with a presence-only strategy appropriate for IAS. Presence-only models are calibrated by contrasting the environment at locations in which the species is known to occur with the environment in randomly-selected 'pseudo-absences', i.e. background locations without presences. Our method for selecting pseudo-absences accounted for spatial variation in recording effort, as well as dispersal constraints on their global distributions. Models were estimated using a range of statistical algorithms implemented via the BIOMOD package for R, resulting in an ensemble prediction of potential invasion of the EU in both the current climate and for climate model projections of conditions in the late 21st century. We suggest that by adopting a standardised modelling workflow in risk assessment, predictions of potential invasive distributions will be more transparent and comparable across different species. This will provide a more secure basis for deciding how to prioritise management to most effectively mitigate the impacts of IAS as a whole.

Keywords: Risk assessment, pest risk analysis, ecological niche model, climate matching, BIOMOD, presence-only modelling

Non-native and diadromous fish distributions in running waters using environmental DNA

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For aquatic species that are present in low density or difficult to capture, environmental DNA (eDNA) analysis of water samples has proved to be an effective and efficient means for detecting these species where conventional means fail. The eDNA approach is therefore of particular interest with regard to diadromous species, several of which are in decline, including European eel *Anguilla anguilla*, European smelt *Osmerus eperlanus*, sea lamprey *Lampetra marinus* and river lamprey *L. fluviatilis*. With potentially invasive non-native species, eDNA analysis of water samples can provide an early warning of their presence, thereby providing environmental managers with the possibility of a rapid response to eradicate or contain the unwanted species. Non-native fishes that warrant monitoring in the UK are two currently invasive species (topmouth gudgeon *Pseudorasbora parva*, sunbleak *Leucaspis delineatus*) and two species not currently invasive but expected to become invasive during future warmer climatic conditions (pumpkinseed *Lepomis gibbosus*, fathead minnow *Pimephales promelas*). This communication will present recent field and laboratory results in the development and application of eDNA in rivers and streams in southern England, where the potential exists for the co-occurrence and potential interaction between native diadromous and existing non-native species. This work, carried out in summer 2016, will address two main objectives: 1) determine the occurrence and distribution of native diadromous fishes and lampreys and of non-native fishes: 2) assess whether invasive fishes are inhabiting water courses adjacent to the floodplain still waters they have infested, including those where the invasive species has been eradicated.

Keywords: *Pseudorasbora parva*, *Anguilla anguilla*, *Osmerus eperlanus*, *Lepomis gibbosus*, *Leucaspis delineatus*, *Lampetra* sp.

Assessing the risk of potentially invasive woody plant species in Armenia

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Currently, the problem of invasive species in Armenia is very serious. Despite recognition of the problem by the scientific community and the Ministry of Nature Protection of Armenia, in political terms, there are no actions provided. In Armenia, almost uncontrollably many species and varieties of plants are introduced. They are grown in greenhouses and in open ground, are used for both cutting and for gardening of settlements. While in the 5th National Report on Biodiversity, a separate section is devoted to the problem of invasive species; all importing plants are evaluated only in terms of quarantine weeds. This can be explained by passivity of decision-makers, and on the other hand by the absence of necessary guidelines and recommendations.

With a purpose to select criteria for assessing the potential risk of introduction of plants in Armenia, on the basis of Weber and Gut (2004) and Magee et al. (2010) works, we have tried to evaluate the effectiveness of their criteria. Using proposed criteria, we estimated about 200 species of trees and shrubs, currently used and proposed for use in settlements' gardening in Armenia (Vardanyan et al., 2015). Some of these species are aborigine; some are introduced and experienced in the botanical gardens; some are already used in street's gardening or in windbreaks. Among them were the species already known in Armenia as invasive and expansive (Fayvush, Tamanyan, 2014).

It was found that in this particular case such a criterion as "life form" is not acceptable, because only trees and shrubs were studied. Criterion «Climatic match» also has no sense, because the territory of Armenia has great variety of eco-climatic conditions, and it is possible to find connection with almost any corner of the World (except perhaps the tropics and humid subtropics). The same applies to the criteria «Geographic distribution in the Caucasus» and «Range size of global distribution». The investigated species currently are very widespread globally. Other criteria will work in Armenia. However, they need to be supplemented. The criterion «Habitats of species» should include all natural habitats, even disturbed and semi-natural. It is needed to add two more criteria: «Establishment in natural habitats in Armenia» and «The spread on the territory of Armenia in the last 2-3 decades." According to our research, in this case this system of criteria shows high efficiency, and can be used for development of guidelines for the risk assessment.

Keywords: Risk assessment, woody plants, Armenia, invasiveness

P-156

Environmental DNA (eDNA) detection of invasive fish: Performance of eDNA surveillance against traditional monitoring methods in the detection of the Oriental weatherloach (*Misgurnus anguillicaudatus*) in Australia

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The eDNA technique is a new detection method that is gaining credibility as a rapid and sensitive detection tool useful in the surveillance/monitoring of invasive or threatened species. Environmental DNA analysis requires a sample derived from either soil, permafrost, marine or freshwater environments. DNA is extracted directly from the sample, and amplified using conventional PCR or quantitative PCR (qPCR) methods. Despite the eDNA method's increasing popularity as a detection tool, its adoption by management agencies will depend on its performance and resource efficiency compared to current surveillance methods. In this presentation, we report the results of a study comparing the detection of an invasive fish, *Misgurnus anguillicaudatus*, using eDNA and traditional detection methods (fyke netting and backpack electrofishing) in a natural river system with a known density gradient of the target species. We also present some of the challenges associated with implementing the eDNA method in the field and recommend ways to improve sampling and detection using eDNA.

Keywords: environmental DNA, fyke netting, electrofishing, detection, monitoring, invasive species

The contribution of traits to detectability of exotic plant species in tropical forest originated from botanic gardens: Line transect distance sampling and Bayesian hierarchical modelling

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Detection and detectability are essential components in exotic invasive species management. Detectability refers to the extent to which something is detectable. Detectability model accommodate the inclusion of possible factors which are influence species' detectability, and can be useful to support estimation of detection effort allocation. This study aims to investigate how common visual exotic plant characteristics (leaves shape, leaf area and exotic plant height) and survey locations contribute to the detectability of exotic plant species in secondary tropical rainforests originated from botanic gardens, given the application of line transect distance sampling method. We used a hierarchical distance sampling model to estimate the contribution of leaf shape, leaf area, and plant height to exotic plant species detectability. We found positive correlations between leaf area and plant height with detectability of the exotic plant species. Detectability of the exotic species also varied among the different survey locations. We did not find contribution of leaf shape on exotic plant detectability. This study shows the contribution of leaf area and plant height on the detectability of exotic plant species in tropical rainforest environment. This study exhibits that an application of hierarchical model is beneficial for investigating trait-based detectability model in line transect distance sampling method.

Keywords: Bayesian hierarchical model, botanic gardens, detection model, invasive plant, plant functional traits, distance sampling, tropical rainforest.

P-158

Predicting potential distribution of five priority invasive plant species in Sri Lanka through species distribution modeling

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This study has modelled the suitable climate area for five invasive species in Sri Lanka, *Mimosa pigra*, *Annona glabra*, *Lantana camara*, *Prosopis juliflora* and *Parthenium hysterophorus* under current climate scenarios using Maxent model using geo-reference presence-only location data and selected seven climate parameters. These species are considered as priority invasive plants in Sri Lanka as well as several other countries in the world.

The discrimination capacities of these distributional models were determined by calculating the area under the receiver operating characteristic curve (AUC) criterion. The resulting models were found to have good discrimination ability of presence and absence, with very high AUC values of 0.888, 0.989, 0.910, 0.821 and 0.998 for *Mimosa pigra*, *Annona glabra*, *Lantana camara*, *Prosopis juliflora* and *Parthenium hysterophorus* respectively.

The Study identified highly responding variables for the model prediction of each species. Maps produced in this study can be a useful tool for protected area managers to take information based decisions. Also they can be used in public awareness campaigns so as to enlist the help of local communities in the management of existing infestations and the prevention of further invasion.

The predictions we received for these species were quite realistic because occurrence points were overlaid on the prediction areas. This implies that the Maxent fitted models for these species in Sri Lanka have captured the considerable environmental variable gradient of the species concerned. The vulnerable forest, wildlife and agro-ecological regions were identified for the five species considered. The maxent prediction for each species was compared with predictions received using other algorithms (glm, bioclim and domain) in R interphase.

Keywords: invasive, species distribution modelling, maxent, Sri Lanka, *Mimosa pigra*, *Annona glabra*, *Lantana camara*, *Prosopis juliflora*, *Parthenium hysterophorus*

Mapping current *Prosopis spp.* spread with Landsat 8 imagery in Hargeisa, Somaliland

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Prosopis spp., native to the American dry zones, are fast and aggressive invaders threatening many arid and semi-arid areas globally. The species were introduced in Somaliland for dune stabilization and providing fuelwood in the 1970s and 1980s, as its deep rooting system is capable of tapping into the ground water table rendering it less reliant on rain water and more drought tolerant. The invasion was aggravated by a hybridization process where a number of introduced sub-species evolved in a hybrid species specifically adapted to the environmental conditions, rendering it a superior and aggressive competitor to endemic species. A study by Rembold et al. (2015) determined that the invasion of *Prosopis* is acute and affecting rivers, wadis (in Somaliland referring to ephemeral rivers, usually dry except during the rainy season) and water bodies as well as urban and peri-urban environments. The study pointed out that further remote sensing efforts are needed to map *Prosopis*. The aim of this research was to map the current spread of *Prosopis* by performing a pixel and object based analysis through a non-parametric Random Forest classifier on Landsat 8 earth observation satellite data of different seasons (wet and dry season). The study area is located in the Hargeisa area in Somaliland and reference data was collected through fieldwork during the dry season of 2015. The results were validated by applying a 10-fold cross-validation and we created map output of the best performing models. Our findings suggested that the pixel based approach provides a better overall accuracy (74%) and produced the best map. However, the object based results performed better for the *Prosopis* classes. The results indicated an increase in accuracy when using dry season data and in addition, coiflet wavelets and pan-sharpening slightly increase the overall accuracy.

References

Rembold, F., Leonardi, U., Ng, W., Gadain, H., Meroni, M., 2015. Mapping areas invaded by *Prosopis juliflora* in Somaliland with Landsat 8 imagery. Proc. Of SPIE Vol. 9637, 1–12. doi:10.1117/12.2193133

Keywords: Remote sensing, *Prosopis*, invasive species, mapping, Random Forest classifier, Somaliland

Monitoring and Information System for Invasive Species: A Step towards Early Detection and Rapid Response in Turkey

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The biological invasions on global and regional scales present severe ecological, agricultural and health concerns resulting in considerable economic losses. However, absence of the reliable data on the occurrence of invasive species results in great challenges for their management. Moreover, lack of reporting the first occurrence of exotic species provides sufficient time to further invasion and spread over regional scales. The presence of monitoring and information system (MIS) for invasive species on regional and global scales can help to inform necessary authorities and thus solve these problems to considerable extent. This study reports the creation and working environment of MIS for invasive species in Turkey. The MIS is freely accessible in local language (Turkish) through the website (www.i-bil.com). Initially, MIS focuses on invasive plants and provides detailed information on the occurrence, biology, ecology, possible risks for the country and management options for 50 plants. Surveys have been conducted over considerable portion of the country for the most noxious plants. The data on occurrence of the plants will be spatially analyzed for different regions of country according to the severity of invasion. The spatial distribution maps of different plants will be available on the website. Potential distribution maps of the plants under different climate change scenarios will also be prepared and posted. The system will be user friendly that will allow easy reporting of any new occurrence in the country. The newly reported species will be identified and information will be updated by the experts working on the particular species. Based on the potential distribution and possible risks associated with invasive species, early warnings will be issued for different areas at risk. The public awareness will be created through different media sources. Rapid response actions will be taken against the most lethal species through the collaboration of public and government agencies. Recommendations will be made from time to time for different species for policy making and quarantine measures. The system will also be available in English for the access of higher number of stakeholders from all over the world. A Smartphone application will also be made available to enter the observation of invasive species, location and pictures etc. to update the maps and distribution of the particular species.

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Keywords: Invasive species, Early detection, Monitoring and information system

Black, Grey and Watch Lists of alien species in the Czech Republic

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As legislation, research and management of invasive alien species (IAS) are not fully coordinated across countries or different stakeholder groups, one approach leading to more or less standardized activities is based on producing lists of prominent IAS that attain high level of concern and are a subject of priority monitoring and management (Black, Grey and Watch - alert Lists). It is important that these lists be based on transparent and robust criteria so as to accommodate interests and perception by various groups of concerned authorities and stakeholders, and to justify possible trade restrictions. The principles for blacklisting need to be general enough to accommodate differences among taxonomic groups (plants, invertebrates, vertebrates) and invaded environments (e.g. aquatic, terrestrial, urban, suburban, seminatural) and management strategies suitable for each particular invader.

We synthesized available information to present Black, Grey and Watch Lists of alien species for the Czech Republic, with recommended categorized management measures for land managers, policy makers and other stakeholders. We took into account differences in the listed species' distribution, invasion status, known or estimated environmental impact, as well as possible management options

In total, there are 78 plant and 39 animal species on the Black List, 47 and 16 on the Grey List, and 25 and 27, respectively, on the Watch List. The multilayered approach to the classification of alien species can serve as a model for other countries that are in process of developing their Black Lists.

One of the important aspects of such a work is that it can stimulate discussion on the assessment of individual species as well suggestions of possible additions or deletions, from people involved in research, management, as well as general public.

Keywords: animals, invasions, legislation, plants, risk assessment

Invasiveness, impact, and ecosystem engineering: connecting different approaches for estimating invader performance

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In view of increasing invasion rates due to intensifying global trade and traffic, efforts to assess and predict the 'performance' of alien species in terms of their invasiveness and environmental impact in the introduced area are increasing. Accordingly, the number of approaches proposed for such assessments is increasing as well. We applied and compared two different assessment methods for introduced European and North American birds, fishes, and mammals: the recently proposed Environmental Impact Classification for Alien Taxa ('EICAT') and the prototype of an assessment scheme that is currently being developed for the German Federal Agency for Nature Conservation in compliance with the new EU regulation on IAS ('NIB 2.0'). While EICAT is a genuine impact assessment scheme, collecting information on current and maximum recorded detrimental impacts of alien species on the environment, NIB 2.0 assesses the extent as well as the risk of such impacts. Both schemes classify the assessed species on an ordinal scale regarding impact severity and general invasiveness, respectively. We compare and interrelate the final classifications of both assessment methods with each other and additionally with an index of ecosystem engineering intensity ('Engineering Class Index'). We present preliminary results of this analysis in regard to the relationship among the degree of impact, invasiveness, and engineering intensity, and between these and the invasion stage reached by the alien species (introduced, established or spreading). We state implications of these results with regard to potential connections and synergies between such different assessment approaches to gain a more reliable and comprehensive picture of alien species' (potential) impacts.

Keywords: assessment scheme, biosecurity, ecological impact, Europe, impact comparison, invasive species, North America, prevention, socio-economic impact

An updated EPPO prioritization process to select high priority plant species for risk assessment following the criteria of the Regulation (EU) No. 1143/2014

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When originally published in 2010, the EPPO prioritization process for invasive alien plants was designed with emphasis on plant health concerns which place an emphasis on economic and ecological impacts. However, when applied in the context of the Regulation (EU) No. 1143/2014, more emphasis is now placed on impacts on biodiversity and ecosystem services and thus under the LIFE funded project ‘Mitigating the threat of invasive alien plants in the EU through pest risk analysis to support the EU Regulation 1143/2014’, the EPPO prioritization process was adapted to meet the requirements of the regulation.

The EPPO prioritization process is designed (i) to produce a list of invasive alien plants that are established or could potentially establish in the European Union (EU); and (ii) to determine which of these species have the highest priority for a risk assessment (RA) and, eventually, to be proposed for inclusion in the list of Union concern. Therefore, the process takes into consideration the criteria from the Regulation (EU) No. 1143/2014 on the prevention and management of invasive alien species.

In agreement with Article 4 of this Regulation, the highest priority for performing a risk assessment is given to alien plant species that satisfy the following criteria: (i) they are alien to the territory of the EU excluding the outermost regions, (ii) they are capable of establishing a viable population and spreading rapidly in the environment in the EU (excluding the outermost territories), (iii) they are capable of causing major detrimental impacts to biodiversity and the associated ecosystem services, (iv) actions can be taken to effectively prevent, minimise or mitigate their adverse impact, which involves that they are moved from country to country primarily by human activities and they still have a significant area suitable for further spread within the EU.

The amended prioritization process was first used in February 2016 to select 16 plant species, from a list of 37 species which will now undergo a risk assessment under the aforementioned project. This presentation will introduce the updated prioritization process and evaluate the process used to select the 16 species which have the highest priority for a risk assessment.

Keywords: Invasive alien plants, prioritization process for invasive alien plants, risk assessment

Improving the surveillance for biosecurity threats through network analysisMaggie Triska^{1,2}, Michael Renton^{1,2}¹*The University of Western Australia, Crawley, Australia*²*Plant Biosecurity Cooperative Research Centre, ACT, Australia*

Each year new crop pest invasions occur and result in trade restrictions and economic loss. In regions where a crop pest already exists, uninfested farms are susceptible to invasions from infested farms. Surveillance strategies are designed to detect new invasions early to increase the likelihood of eradication, and thus maintain trade freedom. Current surveillance strategies may be improved through network analysis which identifies highly connected, at risk regions and properties. Network analyses has been successful in tracking the transmission of diseases in livestock and improving surveillance strategies; however, crop related movement is less documented than livestock, and limited data exists on the movement of machinery and people between farms. This is likely why few applied studies assess networks and potential crop pest movement, and we were unable to locate any studies that assessed crop pest movement at the local (farm-farm) scale. Therefore, we modelled a case study of potato-cyst nematode (PCN) infested and susceptible regions, and the farms within them, in Australia to assess if developing risk networks might improve surveillance strategies for the pest. We simulated the spread of PCN over time on a network consisting of infested and susceptible regions and farms (nodes) with links weighted by Euclidean distance and production type (fresh vs seed potatoes). To assess surveillance, we simulated surveys, with detection probabilities dependant on time since invasion, and the potential for quarantine measures after detection. We suggest that network analysis can be used to guide surveillance strategies and has the potential to decrease the time to detection, resources required for eradication and ultimately the spread of crop pests. Additionally, although limited information on specific crop related movement was available, we displayed how publicly available data may be used to improve surveillance strategies and assist in controlling crop pests, which is important to restrict the spread of biosecurity threats throughout the world.

Keywords: Australia, crop pests, early detection, invasive species, potato-cyst nematode, spread model

New Detections of Non-Native Plant Pathogens: Risk Assessment and Uncertainty

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Non-native plant pathogens pose a significant economic risk to Canada's agriculture and forestry sectors, as well as to the natural environment. In assessing the risks posed by non-native plant pathogens to Canadian ecosystems, risk assessment attempts to estimate whether there is a pathway for introduction of the pathogen into Canada, whether the pathogen would be able to establish and spread in Canada (e.g. suitable hosts and climate), and whether there is evidence to suggest that the pathogen would cause economic harm to Canada's environment or agriculture and forestry sectors. Risk assessment of this kind is most commonly done for pathogens that have never before been reported in Canada. However, when a new pathogen is reported for the first time in Canada, risk assessment processes are often triggered to help determine the risk posed by the newly detected pathogen.

Common challenges in risk assessment include a lack of biological information on target species, uncertainty about the behaviour of species in new environments, and lack of information on appropriate treatment methods. Gaps in information and uncertainties in the analysis must be acknowledged. These challenges often come into sharp relief in situations where a new pathogen is identified in an area, and rapid decision-making is required on how to respond to the new detection. Partnering with researchers to develop applied research projects to address areas of uncertainty can be an effective solution to problems associated with lack of information in risk assessment. However, risk management decisions must be made relatively quickly in order to mitigate the impacts of a new incursion. As such, in the case of recent detections, there is usually not sufficient time to develop and implement research projects to be undertaken that can address the gaps in information. Ultimately, even if uncertainty exists about one or more component of the risk assessment, regulatory decisions must be made using the information already available in the scientific literature, even if it is incomplete.

An example of a recent first detection of a plant pathogen in Canada will be used to highlight the information challenges inherent in the risk assessment process, and to explore how these challenges can be effectively managed.

Keywords: risk assessment, plant pathogens, uncertainty, risk

NEOBIOTA - European Group on Biological Invasions

www.neobiota.eu

The European Group on Biological Invasions NEOBIOTA was founded in Berlin 1999 as a consortium of scientists and environmental managers aiming to enhance integration of invasion research and strengthen approaches to counteract negative effects of introduced organisms on biodiversity, ecosystem services and human health.



NEOBIOTA addresses theoretical and applied aspects of biological invasions, but also aims at educating the public and consulting with policy makers.

Main tasks of NEOBIOTA

- Enhance communication and contact between scientists from different (sub-) communities working on theoretical and applied aspects of biological invasions.
- Stimulate research on non-native species, their traits, their distribution and impacts. Identify information deficits and co-ordinate efforts to fill them.
- Disseminate information on causes, mechanisms, and impacts of biological invasions and on management approaches.

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In 2002 NEOBIOTA established a publication series to publish conference proceedings and monographs on invasion topics. Since 2011, this publication series is continued as the peer-reviewed, open-access, rapid online journal NeoBiota launched to accelerate research on all types of alien species and biological invasions.

Organization

The **NEOBIOTA Council** is expected to include two experts from each European country. The main tasks are:

- Represent NEOBIOTA and enhance further work in the field of biological invasions at the national level;
- Represent the national scientific communities and enhance communication and research at the European level.

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- Represent NEOBIOTA and enhance communication and research at the European level;
- Decide on the future development of NEOBIOTA and on the venue of the NEOBIOTA conferences;
- Elect the President and Vice President of NEOBIOTA.

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- 2000 **Biologische Invasionen: Herausforderung zum Handeln?**
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- 2002 **Biological Invasions: Challenges for Science**
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- 2004 **From Ecology to Control**
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- 2006 **From Ecology to Conservation**
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http://www.umweltbundesamt.at/umweltschutz/naturschutz/nat_veranstaltungen/neobiota/
- 2008 **NEOBIOTA: Towards a Synthesis**
5th International Neobiota Conference on Biological Invasions
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<http://www.ibot.cas.cz/neobiota/>
- 2010 **Biological Invasions in a Changing World – From Science to Management**
6th Neobiota Conference
Copenhagen, Denmark – September 14–17
- 2012 **Biological Halting Biological Invasions in Europe: from Data to Decisions**
7th Neobiota Conference
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<http://www.neobiota2012.blogspot.com>
- 2014 **Biological Invasions: From understanding to action**
8th International Conference on Biological Invasions
Antalya, Turkey – November 3-8
- 2016 **Biological Invasions: Interactions with Environmental Change**
9th International Conference on Biological Invasions
Vianden, Luxembourg – September 14-17
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Index of authors

Adam, Mildren	51	Benesperi, Renato	217, 218
Adriaens, Tim	75, 205	Bernard-Verdier, Maud	30
Adrian-Kalchhauser, Irene	77, 178, 179, 223	Bertelsmeier, Cleo	24
Águas, Maria	87	Bertolino, Sandro	72
Aikio, Emmi	62	Beshkov, Stoyan	172
Aizen, Marcelo Adrián	48	Bessonov, Sergey A.	38
Aksoy, Necmi	155, 173	Bianchi, Elisabetta	217, 218
Albov, Sergey A.	38	Bienkowski, Andrzej O.	152
Aleksanyan, Alla	180, 233	Biurrun, Idoia	115
Alexander, Jake M.	144	Blackburn, Tim M.	43
Allen, William	34	Blasi, Carlo	207
Anastácio, Pedro	87, 139, 228	Blasius, Bernd	46
Anastasiu, Paulina	173	Błóńska, Dagmara	123
Aquiloni, Laura	226	Bochkin, Vassily	162
Arianoutsou, Margarita	206	Bode, Michael	117, 223
Arnberger, Arne	63	Boeck, Sebastian	237
Arslan, Zubeyde Filiz	155	Boivin, Thomas	208
Atzberger, Clement	237	Bojare, Aiva	120
Auge, Harald	183	Bollens, Ursula	211
Auger-Rozenberg, Marie-Anne	181	Boltsis, Evangelos	124
Avtzis, Dimitrios N.	181	Bon, Marie-Claude	214
Baard, Johan	55	Bonnaud, Elsa	71, 129
Baccetti, Nicola	207	Borcherding, Jost	178
Bacela-Spychalska, Karolina	60, 99, 109, 130, 196	Born-Schmidt, Georgia	174, 198, 229
Baker, Christopher	223	Borrell, Yaisel J.	226
Bancheva, Svetlana	137	Botková, Katarína	104
Banha, Filipe	139, 228	Bouhache, Mohamed	214
Barba Macías, Everado	174	Bourguet, Edouard	129
Bargeron, Charles T.	64, 209	Bouteiller, Xavier P.	62
Barrera, Denisse	54	Bozsó, Miklós	84, 167, 220
Barrett, Mauri L.	37	Bozzuto, Claudio	223
Barrios, Yolanda	198, 229	Branquart, Etienne	75, 241
Bartáková, Veronika	116	Bras, Audrey	181
Bastos, Rita	161	Brockerhoff, Eckehard	53
Basurko, Oihane C.	226	Broennimann, Olivier	23
Bauer, Nicole	63	Brook, Alex	70
Bawin, Thomas	170	Brown, Pike	174
Bayliss, Helen	51, 208	Bruelheide, Helge	190
Bayón, Álvaro	197	Brůna, Josef	156
Bazalová, Denisa	104	Brundu, Giuseppe	155, 241
Bazos, Ioannis	206	Buckley, Yvonne	131
Beckage, Brian	31	Buga, Sergey	166, 182
Behrmann-Godel, Jasminca	178	Buholzer, Serge	241
Bell, Carl	214	Bukun, Bekir	202
Bendoni, Michele	122	Burgiel, Stanley	221
		Burgman, Mark A.	235
		Burkhardt-Holm, Patricia	77, 178, 179, 223

Cabral, João A	161	Daïnou, Kasso	62
Campbell, Karl	221	Dajdok, Zygmunt	135
Canavan, Susan	64	Danielewicz, Wladyslaw	135
Cantú Salazar, Lisette	140	Daru, Barnabus	103
Capellini, Isabella	34	Davies, Sarah J.	61, 64
Capinha, César	139, 147	Davison, Phil I.	232
Capizzi, Dario	207	Dawidowicz, Piotr	90
Cardoso, Ana - Cristina	206	Dawson, Wayne	32, 45, 147, 154
Carli, Emanuela	207	de Jesús, Silvia	198, 229
Carrete, Martina	197	de la Rosa Padilla, Alberto	88
Carrion, Alonso	54	De Méringo, Hélène	129
Casaer, Jim	75	de Thier, Oliver	62
Cassan, Jean-Jérôme	71	de Weger, Letty A.	67
Castelli, Cristina	207	Debar, Leo	129
Castro, Karen	230	Dehnen-Schmutz, Katharina	92, 200, 208
Catford, Jane A.	117, 235	Delcamp, Adline	62
Causton, Charlotte	54	Delgado, Jesus F	226
Celesti-Grapow, Laura	207	Delipetrou, Pinelopi	206
Céline, Bellard	118	Dergunova, Natalia N.	38
Čeplová, Natálie	165	D'Errico, Giada	36
Chaillon, Corentin	71	Dewulf, Evy	205
Chapman, Daniel	231	Dgebuadze, Yuri Yu.	38
Chauvel, Bruno	67	Ditton, Julia	94
Cheney, Chad	55	Divisek, Jan	31
Chown, Steven	32	Donrovich, Seth	119
Christian, Svenja	199	Doroftei, Mihai	142, 143
Christopher, Mandy	53	Douce, G. Keith	64, 209
Christopoulou, Anastasia	206	Douda, Karel	110, 119
Chucholl, Christoph	168	Downey, Paul	64
Chytry, Milan	31, 115, 146	Doychev, Danail	172
Cimadom, Arno	54	Dragota, Carmen	143
Claire, Wilson M.	37	Drygala, Frank	57
Clusella-Trullas, Susana	24	Ducouso, Alexis	195
Cogalniceanu, Dan	204	Dullinger, Iwona	83
Consoli, Vito	207	Dullinger, Stefan	45, 83, 147
Consortium, MIREN	47	Dumitrascu, Monica	142, 143
Constantine, Kate	70	Dumitrica, Cristina	143
Cook, David	53	Dunn, Alison M.	50, 134
Cook, Elizabeth	210	Duplic, Aljosa	204
Copiz, Riccardo	207	Durner, Jörg	185, 186
Copp, Gordon H.	232	Dzialowski, Andrew	90
Coppi, Andrea	127	Dzierżyńska-Białończyk, Anna	89
Cossu, Tiziana	155	Eckert, Silvia	184, 189
Cousens, Roger David	111	Economo, Evan	147
Crandall, Raelene	176	Economou, Garifalia	173
Créach, Véronique	232	Egidi, Isabella	207
Crnov, Rosa	53	Ehret, Pierre	241
Čuda, Jan	28, 156	Enders, Martin	201
Cybèle, Cathleen	64	Eppink, Florian	174
D'hondt, Bram	75, 205	Erfmeier, Alexandra	21, 190
Daignault, Adam	174	Ernst, Dieter	185, 186

Eschen, René	70	Giuchoux, Erwan	62
Escribano-Alacid, Josep	197	Giuliani, Claudia	36, 127
Essl, Franz 32, 45, 46, 51, 83, 147, 154, 208		Gkenas, Christos	228
Evarte-Bundere, Gunta	120	Gladyshev, Michail	90
Evarts-Bunders, Peteris	120	Gleeson, Dianne	234
Fabiani, Arturo	36	Golubkov, Victor V.	38
Falconi, Manuel	153	Golubov, Jordan	229
Farooq, Shahid	22, 80, 193, 238	González Martínez, Ana Isabel.....	174, 198, 229
Fattori, Cristiano	207	González, Luís	127
Faulkner, Katelyn Terri	76	González, Pablo	44
Fayvush, Georgi	233	González-Moreno, Pablo	48, 70, 74
Feniova, Irina Yurievna	90	Goryainova, Zoya I.	38
Ferretti, Giulio	217, 218	Gotelli, Nicholas	31
Ferus, Peter	142, 143	Gotti, Camilla	207
Filipe, Ana Filipa	139	Gough, Peter	226
Fill, Jennifer Marie	55	Gouyet, Raphaël	71
Finger, David christian	204	Grabowska, Joanna	123
Fingu, Junior Corneille	170	Grabowski, Michał	60, 196
Fischer, Daniel	63, 69, 211	Gregori, Sascha	211
Fischer, Kathrin	69	Greve, Michelle	32, 103
Fletcher, John	53	Griffiths, Charles	64
Flevaris, Spyridon	73	Grigorescu, Ines	142, 143
Florjanová, Anna	91, 98, 121	Groom, Quentin	155, 187
Foggi, Bruno	36, 127, 217, 218	Gudžinskas, Zigmantas	81, 138, 157
Follak, Swen	51	Guénard, Benoit	147
Forsyth, Aurelia T	55	Guillera-Arroita, Gurutzeta	235
Forsyth, Greg G	55	Guisan, Antoine	23
Francis, Frédéric	169, 170	Gulbinas, Zenonas	157
Frank, Ulrike	185, 186	Gunal, Hikmet	22, 80, 193
Frantz, Alain	57, 58	Guo, Wen-Young	28
Fried, Guillaume	241	Haider, Sylvia	144
Frondoni, Raffaella	207	Hall, Barbara	53
Fuentes-Ramirez, Andrés	127	Hall, David	226
Furlan, Elise	234	Hall, Rea Maria	93, 97, 177
Gaertner, Mirijam	64	Hallmann, Caspar	68
Gago, João	228	Hanzelka, Jan	188
Galindo, Carlos	198	Harrison, Laura	208
Gallardo, Belinda	44, 141	Hattab, Tarek	47
Gama, Ana Mafalda	139	Haubrock, Phillip	122, 226
Gangur, Alex	92	Hauck, Stefanie	186
Garcia de Leaniz, Carlos	226	Havlickova, Vendula	86
García-Vázquez, Eva	226	Heckel, Gerald	23
Garnas, Jeff	24	Heddergott, Mike	58
Gavriil, Elissavet	173	Hegedúšová, Katarína	104
Gbèhounou, Gulabert	214	Heger, Tina	94, 177
Geron, Charly	20	Hejda, Martin	188
Gertzen, Svenja	178	Hempel, Stefan	27
Gervasini, Eugenio	206	Herden, Jasmin	184, 189
Gévaudant, Frédéric	62	Herlo, Gabriel	142
Giesler, Rebecca J	210	Heuskin, Stéphanie	169
Gioria, Margherita	25, 26, 107		

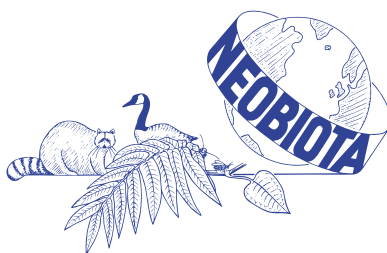
Hill, Matthew P.	24, 141	Kashefi, Javid	214
Hinlo, Rheyda	234	Katsanevakis, Stelios	124
Hirsch, Philipp E.	178, 223	Kauzál, Ondřej	158
Hock, Maria.....	190	Kavriga, Natalja.....	120
Hodda, Mike.....	53	Kawai, Tadashi	168
Hofmann, Rainer	190	Kazannyk, Vitalii.....	85, 132
Hollis, Sarah.....	240	Kazinczi, Gabriella	67, 97
Honrado, João Pradinho	161	Keller, Joseph A.....	78, 82
Horáček, Ivan	158	Keller, Stephen	192
Horky, Pavel.....	119	Kenis, Marc.....	39, 74, 181, 215
Hoste, Ivan	187	Kerepesi, Ildikó.....	97
Hovis, Ciara L.	78	Khlyap, Lyudmila A.	38
Hruskova, Karolina	86	Khvir, Viktor.....	125
Hubenov, Zdravko.....	204	Kilbey, David.....	226
Hufbauer, Ruth A.	78, 191	Kirichenko, Natalia.....	215
Hulme, Philip	30, 53, 75	Klonner, Günther	83
Hunziker, Marcel.....	63	Klotz, Stefan	27
Hussner, Andreas	95	Knight, Tiffany	29, 114, 176
Hutter, Hans-Peter.....	51	Knobová, Pavlína.....	98
Immitzer, Markus	237	Knollova, Ilona	115
Inghilesi, Alberto.....	36, 122, 212, 226	Knop, Eva	23
Ireland, Kylie B.....	53	Kobak, Jarosław... 89, 96, 99, 109, 123, 130	
Irina, Ionescu Malancus	159, 160	Koch, Marcus A.....	113
Ivey, Philip	64	Kokkoris, Yannis	206
Jäger, Heinke.....	54	Koleff, Patricia.....	174, 198, 229
Jamieson, Lisa	53	Konstantinovic, Bojan	173
Janssens, Steven	187	Kos, Katarina	167, 220
Janulioniene, Rasa.....	126	Kostrzewska-Szlakowska, Iwona	90
Jarolímek, Ivan.....	104, 105	Kouba, Antonín.....	168
Javal, Marion.....	59	Kozubíková-Balcarová, Eva.....	168
Jelaska, Sven D.	145	Kraaij, Tineke	55
Jermacz, Łukasz	96, 109, 123, 130	Kreft, Holger.....	32, 45, 147, 154
Jeschke, Jonathan	33, 112, 201, 240	Kremer, Antoine	195
Jiménez-Alfaro, Borja	115	Krippel, Yves.....	216
Jociene, Lina.....	126	Kriston, Éva	84, 167, 220
Johovic, Iva	212, 226	Krizbai, László.....	84, 167
Jones, Chad C.....	49	Krzywoźniak, Paula.....	196
Jones, Clive G.	240	Kucsicsa, Gheorghe	143
Jongejans, Eelke.....	68	Kudsk, Per.....	67, 97
Joshi, Jasmin	184, 189	Kueffer, Christoph	66, 144, 161
Jourdan, Hervé	129	Kühn, Ingolf.....	27, 183
Junaedi, Decky	235	Kumschick, Sabrina.....	35, 64
Junge, Xenia.....	63	Kupcinskiene, Eugenija	126
Kadlec, Tomáš.....	188	Kurose, Daisuke.....	70
Kakareko, Tomasz.....	109, 123	Kuscicsa, Gheorghe	142
Kalusová, Veronika.....	146	Lacković, Nikola.....	167, 220
Kalwij, Jesse M.	21	LaForest, Joseph H	64, 209
Kanchi Díaz, Diego	174	Lagomarsino, Alessandra	36
Kaplan, Haylee.....	64	Lagopodi, Anastasia	214
Kariyawasam, Champika Shyamalie.....	236	Laizet, Yech'an	62
Karrer, Gerhard	67, 93, 97, 173, 177, 213	Landi, Silvia.....	36

Langourov, Mario	172	Marsh-Smith, Stephen	226
Lassois, Ludivine	62	Martín Osorio, Victoria Eugenia	88, 102
Lastrucci, Lorenzo.....	36	Máté, Sándor.....	97
Laštůvka, Zdeněk	239	Mathakutha, Rabia.....	103
Latimer, Andrew M.....	94	Mathiassen, Solveig Kopp	97
Laurino, Daniela.....	72	Mathivet, Mathieu.....	129
Lazzaro, Lorenzo.....	36, 127, 217, 218	Matošević, Dinka.....	84, 167, 220
Le Corre, Valérie.....	180	Maurel, Noëlie	41
Le Maitre, David	55, 64, 175	Mazza, Giuseppe.....	36, 122
le Roux, Peter	32, 103	McCarthy, Michael A	235
Lee, Carol E.....	56	Measey, John G.	61, 64, 128
Lee, Matthias.....	129	Medvecká, Jana.....	104, 105
Lejeune, Philippe.....	62	Melbourne, Brett A.....	191
Lembrechts, Jonas J.....	20, 47	Melika, George	84, 167, 220
Lener, Felicia.....	97	Memmott, Jane	131
Lenoir, Jonathan	20, 47	Méndez Sánchez, Federico	174
Lenzner, Bernd.....	45, 147	Mengal, Coralie	62
Leonardi, Ugo.....	237	Menzel, Andreas.....	27
Leskovšek, Robert.....	97	Merceron, Nastasia M.....	195
Lesutienė, Jūratė.....	133	Meroni, Michele	237
Levin, Samuel Conner.....	29	Mesgaran, Mohsen Behastian.....	111
Linder, Madli.....	219	Mestdagh, Xavier.....	140
Lintermans, Mark	234	Meyerson, Laura	221
Linzmaier, Stefan Markus	33	Meyerson, Laura A.	28
Lioy, Simone	72	Michling, Florian	113
Lira-Noriega, Andrés	148	Milakovic, Ivana.....	213
Liu, Huanzhang	119	Milbau, Ann.....	20, 47
Łodygowska, Małgorzata.....	109	Milbrath, Lindsey	192
Logan, David.....	53	Millon, Alexandre.....	71, 129
Lommen, Suzanne T.E.	67, 68, 225	Mitka, Józef	164
López-Mejía, Marilú	174	Molofsky, Jane.....	31, 192
Lorenzo, Paula.....	127	Monaco, Andrea	207
Lososová, Zdeňka	149, 150, 165	Monteoliva, Augustus.....	226
Lučanová, Magdalena	28	Montero-Castaño, Ana.....	48
Maceda-Veiga, Alberto	197	Montes García, Celerino.....	174
Mack, Richard.....	100	Montowska, Karolina	109
Maguire, Dorothy Yasmine.....	151	Monty, Arnaud.....	62, 106, 108, 195
Mahy, Grégory	106, 108	Moora, Mari.....	27
Májeková, Jana.....	105	Moore, Niall.....	75
Malecore, Eva Maria	101	Moorhead, David J.....	64, 209
Mamos, Tomasz	60, 196	Morales, Carolina Laura	48
Mang, Thomas.....	45	Moravcová, Lenka	86, 107
Manino, Aulo	72	Moreau, Sophie.....	170
Mantoani, Mauricio Cruz	25	Moser, Dietmar	45, 147
Marchante, Elizabete.....	161	Mrugala, Agata	168
Marchante, Hélia	161	Mucina, Ladislav	146
Marchenko, Natalia F.....	38	Muha, Teja P.....	226
Mariette, Stéphanie.....	62	Müller, Caroline.....	19, 113
Markova, Anna.....	85	Müllerová, Jana.....	222
Marozas, Vitas.....	126	Müller-Schärer, Heinz	67, 68, 225
Marques, Monica.....	87	Münzbergová, Zuzana	91, 98, 121

Musil, Jiří	239	Poznańska, Małgorzata	109, 123
Nastase, Mihaela	142, 143	Prądzynski, Daniel	109
Naydenova, Tsvetelina	137	Pratt, Corin	70
Ng, Wai-Tim	237	Preisser, Evan L	37
N'Guyen, Anouk	178, 223	Provoost, Sam	205
Nijs, Ivan	20, 47	Przybylski, Mirosław	110, 123
Nikolić, Toni	145	Pullin, Andrew S	51
Nitcis, Maris	120	Punke, Daniel	240
Normant-Saremba, Monika	87	Pyšek, Petr 26, 27, 28, 31, 32, 43, 44, 45,	86, 107, 115, 146, 147, 154, 155, 156,
Novoa, Ana	64	158, 188, 239	
Nunes, Ana Luisa	64, 128	Pyšková, Klára	158
Nuñez, Martín	20	Quevauvillers, Samuel	62
Oedin, Malik	71	Rabitsch, Wolfgang	51
Olivier Brönnimann, Olivier	225	Rachalewski, Michał	99, 130
Olschewski, Roland	63	Raganella Pelliccioni, Elisabetta	207
Omelchenko, Andrey V	38	Raimbault, Alexandre	62
Onen, Huseyin 22, 80, 180, 193, 202, 238		Ramos-Rendón, Agueda Karina	174
Orians, Colin Mark	37	Rat, Milica	173, 204
Orlova-Bienkowskaja, Marina J	152	Razlutskiy, Vladimir	90
Ortmans, William	106, 108	Rebelo, Rui	139
Osborne, Bruce	25	Rech, Sabine	226
Osorio-Olvera, Luis	148, 153	Rehwald, Heidi K	226
Osten-Sacken, Natalia	58	Reichard, Martin	110, 116, 119
Oude Lansink, Alfons GJM	67	Reif, Jiří	188
Ozaslan, Cumali	22, 80, 193, 202, 238	Reinhold, Wilfred	203, 224
Ozcan, Selcuk	202	Rekasius, Tomas	126
Pagitz, Konrad	194	Rembold, Felix	237
Paini, Dean	53	Renton, Michael	242
Palacio-Lopez, Kattia	192	Rewicz, Tomasz	60, 196
Palmas, Pauline	71, 129	Rey, Anaïs	226
Paris, Enio	122	Reynet, Patrick	195
Parpal Servole, Jordi	174	Ribeiro, Filipe	139, 228
Pastorelli, Roberta	36	Richardson, David M	31, 64, 161, 175
Pauchard, Aníbal	20, 127, 144	Richarz, Frank	216, 224
Paulauskas, Algimantas	126	Rico, José M	226
Pergl, Jan 32, 45, 115, 147, 154, 155, 239		Rigaud, Thierry	60
Perglová, Irena	239	Rigault, Frédéric	71, 129
Pescott, Oliver	231	Rillig, Matthias C	27
Petrášová, Mária	104	Ripley, Brad	103
Petrassi, Fabrizio	207	Robeck, Philipp	111
Petrosyan, Varos G	38	Robertson, Mark Peter	24, 76
Petrulaitis, Lukas	81	Robinson, Tamara B.	64
Petrusek, Adam	168, 239	Roderick, George K	225
Pfitzner, Bianca	240	Rodoni, Brendan	53
Pipek, Pavel	43	Rodríguez Mercado-Silva, Norman	174
Plechingerova, Vera	119	Rodríguez, Jacqueline	54
Plein, Michaela	223	Rodríguez-Ezpeleta, Naiara	226
Pliszko, Artur	163	Rodríguez-Rey, Marta	226
Poltavsky, Alexander	225	Rolla, Matteo	226
Porporato, Marco	72	Romano, Antonio	207
Porté, Annabel J	62, 195		

Roques, Alain.....	59, 181	Skabeikis, Artūras.....	133
Rot, Mojca.....	167, 220	Skálová, Hana.....	28, 86, 107, 156
Roth, Nina.....	47	Skjoth, Carsten A.....	67
Rouget, Mathieu.....	76	Škodová, Iveta.....	104
Rousselet, Jérôme.....	181	Skukan, Roberta.....	226
Roux, Géraldine.....	59	Slavik, Ondrej.....	119
Roversi, Pio Federico.....	36	Smith, Carl.....	110
Roy, Helen E.....	52, 231	Smith, Matt.....	67
Rueff, Franziska.....	186	Soberón, Jorge.....	148, 153
Ruland, Florian.....	112	Soeltner, Ulrike.....	97
Rumlerová, Zuzana.....	156	Solari, Luca.....	122
Runge, Martin.....	58	Sorte, Cascade.....	18
Russo, Laura.....	131	Sousa, Ronaldo.....	139
Rylkova, Katerina.....	119	Sposimo, Paolo.....	207, 226
Rzepecki, Marek.....	90	Stafford, Louise.....	64
Sádlo, Jiří.....	239	Starfinger, Uwe.....	97, 241
Saegesser, Janine.....	69	Stein, Claudia.....	29
Sánchez, Tatiana Berenice.....	174	Steyn, Christien.....	32, 103
Šanda, Radek.....	239	Stift, Marc.....	184, 189
Santos, Mário.....	161	Storch, David.....	158
Sari, Tolga.....	238	Street, Sally.....	34
Sarles, Landry.....	169	Štrobl, Martin.....	188
Sarrocco, Stefano.....	207	Strubbe, Diederik.....	75
Saul, Wolf-Christian.....	240	Suda, Jan.....	28, 192
Sautkin, Fedor Viktorovich.....	171	Sun, Yan.....	67, 225
Scapini, Felicita.....	212, 226	Sushchik, Nadezda.....	90
Schaeffer, Robert N.....	37	Svoboda, Jiří.....	168
Schaffner, Urs.....	67	Szatkowska, Barbara.....	96
Schindler, Stefan.....	51	Szucs, Marianna.....	191
Schley, Laurent.....	140	Tanner, Robert.....	231, 241
Schwabe, Denise.....	240	Taylor, Nigel G.....	134
Schwartz, Assaf.....	75	Tebbich, Sabine.....	54
Seebens, Hanno.....	46, 147	Teixeira, Heliana.....	124
Šefrová, Hana.....	239	Tella, Jose.....	197
Ségura, Raphaël.....	62, 195	Teller, Brittany J.....	78
Seljak, Gabrijel.....	167	Tempera, Fernando.....	124
Serebryakov, Valentyn.....	132	Terblanche, John S.....	24, 141
Serteyn, Laurent.....	170	Teulon, David.....	53
Sevilla, Christian.....	54	Tewes, Lisa Johanna.....	113
Shackleton, Ross T.....	64, 175	Thom, Nikolai.....	70
Shaw, Richard H.....	70	Thomas, Sarah.....	70
Shea, Katriona.....	78, 82, 131	Thompson, Amibeth.....	114
Shelepova, Olga.....	136	Thornber, Carol S.....	37
Sheppard, Christine Sabine.....	42	Thuiller, Wilfried.....	44
Šima, Jan.....	239	Thurston, Graham.....	230
Simoncic, Andrej.....	97	Tilia, Agnese.....	207
Simov, Nikolay.....	172	Tilman, David.....	117
Sinchuk, Aleh Viktorovich.....	171	Tim-Matthias, Strom.....	185
Sinibaldi, Iacopo.....	207	Tokarska-Guzik, Barbara.....	135, 164
Sissons, Andrea.....	230	Tomov, Rumén.....	172, 204
Sjirk, Sjirk.....	64	Torrini, Giulia.....	36

Touza, Julia	64, 208	Vohralík, Vladimír.....	239
Tracy, Johnson M.....	159	von Törne, Christine.....	186
Traian, Manole	159, 160	Vonlanthen, Corinne Maria	227
Traidl-Hoffmann, Claudia.....	185, 186	Voronova, Nina.....	182
Trenchard, Liz.....	92	Vuković, Nina.....	145
Tricarico, Elena	36, 122, 212, 226	Vurro, Maurizio	67
Trickova, Teodora	204	Vyvey, Lindsay.....	243
Triska, Maggie D	242	Wagner, Viktoria	115
Tsiamis, Kostas	206	Wakida – Kusunoki, Armando T.....	174
Turbé, Anne.....	75	Waldhaeuser, Nina.....	97
Turner, Rod	53	Wallner, Peter	51
Tyson, Joy	53	Walser, Jean-Claude	179
Uludag, Ahmet	155, 173, 204, 214	Walther, Gian-Reto.....	211
Uremis, Ilhan.....	155	Wattier, Remi.....	60, 196
Vahsen, Megan.....	191	Watzlawczyk, Sylvester.....	178
Valdez Lizárraga, Mayra.....	174	Weigelt, Patrick	32, 45, 147, 154
Valentin Serebryakov, Valentin	85	Weiss-Lehman, Christopher	191
Valskys, Vaidotas.....	157	Wessely, Johannes	83
van de Wiel, Marco	92	Weyl, Olaf LF.....	128
Van Gompel, Wouter	205	Whattam, Mark.....	53
van Kleunen, Mark 32, 40, 41, 45, 101, 146, 147, 154, 184, 189		Wild, Jan	86
van Klinken, Rieks	53	Wildpret de la Torre, Wolfredo	88, 102
van Valkenburg, Johan.....	241	Wildpret, Wolf-Hermann.....	102
van Wilgen, Brian W.....	55, 175	Wilson, Claire	230
Vanderhoeven, Sonia	75	Wilson, John R.....	64, 76
Varabyova, Maryia.....	182	Wilson, Meriwether	210
Vargas-Amengual, Sergi	197	Winkler, Barbro	185, 186
Vaz, Ana Sofia	161	Winter, Marten.....	32, 45, 83, 147, 154
Ven, Arne	20	Wójcik-Fudalewska, Dagmara	87
Verburg, Peter H	161	Worner, Susan.....	53
Vercruysse, Edward	205	Yannelli, Florencia A.....	177
Verdu, Cindy F.....	62	Yazlık, Ayşe	155
Verhaeghe, Agnès	169	Yazmış, Efecan.....	155
Verheggen, François.....	169	Yesson, Chriss	44
Verreycken, Hugo	75	Yildiz, Hakan.....	80, 202
Verschelde, Pieter.....	205	Zajac, Adam.....	164
Verschwele, Arnd.....	97	Zajac, Maria.....	163, 164
Veselý, Lukáš	168	Zakharov, Ilya A.....	152
Vétek, Gabor	181	Zaliberová, Mária	105
Vicente, Joana Raquel.....	161	Žalneravičius, Egidijus	138, 157
Vidal, Eric	71, 129	Zavyalov, Nikolai A.	38
Vilà, Montserrat	44, 48, 74, 197	Zemanova, Miriam A.....	23
Vilizzi, Lorenzo.....	232	Zenetos, Argyro	204
Viljamaa-Dirks, Satu.....	168	Zengeya, Tsungai.....	128
Vimercati, Giovanni.....	61	Zervou, Sevasti	206
Vinogradova, Yulia	136, 162	Zhao, Feng	185, 186
Vítková, Michaela	222	Zielska, Joanna	96
Vivian-Smith, Gabrielle	53	Zikos, Andreas.....	206
Vladimirov, Vladimir	137, 173, 204	Zobel, Martin	27



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